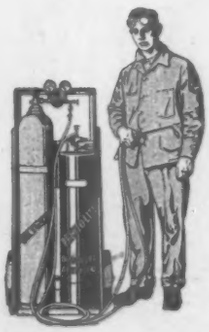
The Welding Engineer

Vol. II. Chicago 608 S. Dearborn St. APRIL, 1917 $2.00 per year in U. S. $2.50 per year abroad No. 4

Oxy-Acetylene Welding and Cutting

Has an Important Place in Production



The Prest-O-Lite Process of oxy-acetylene welding and cutting has demonstrated its splendid utility as a production process in the manufacture of thousands of metal products.

The strength of the oxy-acetylene weld, the speed, adaptability and economy of the process—all point the way to **even greater** possibilities of profitable use in manufacturing fields.

Oxy-acetylene welding is replacing riveted, threaded and brazed joints with better, stronger and neater unions at **less cost.** It is cutting down expensive machine work—doing away with countless bolts, nuts, washers, cotter pins, dowels, flanges, etc.

Older methods, wasteful of time, money, and materials are rapidly giving way to this efficient process.

This process is vital to the profitable manufacture of your metal product.

Let us point out the economies and advantages made possible to **you.**

The Prest-O-Lite Company, Inc.

The World's Largest Makers of Dissolved Acetylene.

U. S. Main Office and Factory, 851 Speedway, Indianapolis, Ind.

Canadian General Office, Toronto, Ontario.

55 Branches and Charging Plants.

Prest-O-Lite PROCESS

*Alphabetical Index to Advertisers and Buyers' Index, Page 4.

The largest makers of Oxy-Acetylene Welding and Cutting Equipment and Supplies in the World

Oxweld Equipment includes Acetylene Generators, Welding and Cutting Blow Pipes, Regulators and Supplies—everything needed for all requirements—complete installations for the most extensive manufacturing and repair operations to portable units for emergency and field use. Because of the scientific accuracy and exactness of design—high quality materials and the mechanical perfection of construction and workmanship, **OXWELD EQUIPMENT** will produce the most efficient and economical results in welding and cutting operations of every character.

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Our knowledge and experience, as the largest makers of welding and cutting equipment in the world, are always at the service of every purchaser and prospective purchaser of **OXWELD APPARATUS,** to determine the most economical and efficient applications of the **PROCESS** to the manufacturing or repair problems at hand.

Write us for information on any class of Welding or Cutting Work

Oxweld Acetylene Company

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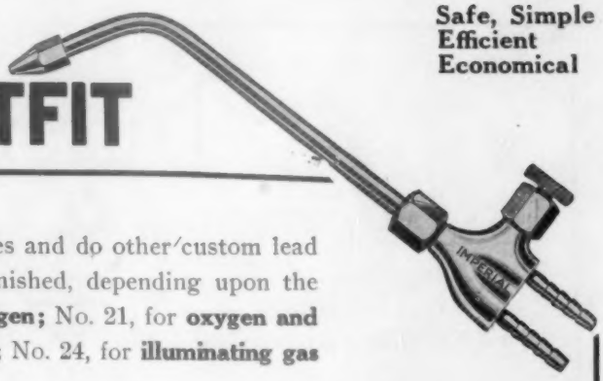
NEWARK, N. J.
6460-680 Frelinghuysen Ave.

LOS ANGELES
654-656 Pacific Electric Bldg.

IMPERIAL LEAD-BURNING OUTFIT

Safe, Simple Efficient Economical



This outfit enables you to burn storage battery plates and do other custom lead burning quickly and efficiently. Four styles are furnished, depending upon the gases you wish to use: No. 20, for **acetylene and oxygen;** No. 21, for **oxygen and hydrogen;** No. 22, for **hydrogen and compressed air;** No. 24, for **illuminating gas and oxygen.**

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For Brazing, they turn out better work than is possible with a welding torch.

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Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

ACETYLENE (Compressed in Cylinders)
Commercial Acetylene Welding Co.
The Prest-O-Lite Co., Inc.
Universal Oxygen Co.

ACETYLENE CYLINDERS
Janney-Steinmetz Co.

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Superior Oxy-Acetylene Mach. Co.
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Universal Oxygen Co.
Vulcan Process Co.

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Davis-Bournonville Co.
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Hauck Mfg. Co.
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Superior Oxy-Acetylene Machine Co.
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United States Welding Co.
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Vulcan Process Co.

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Bermo Welding Apparatus Co.
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Hauck Mfg. Co.
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Vulcan Process Co.

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The Welding Engineer

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Universal Oxygen Co.
Vulcan Process Co.

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Buffalo Dental Mfg. Co.
K-G Welding & Cutting Co.
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$100.00
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WELDING EQUIPMENT COMPLETE,

as shown above, with printed instructions,

$37.50

As high-grade and efficient as any outfit at any price, and no outfit or make could be worth one cent more. We can produce this marvelous outfit only by making these in extremely large quantities, and CASH must accompany orders, as we do strictly a mail order business; there is no other way that we could possibly make this marvelous offer.

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2—10 ft. lengths Hose, per ft.	.14
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WELDIT ACETYLENE CO.

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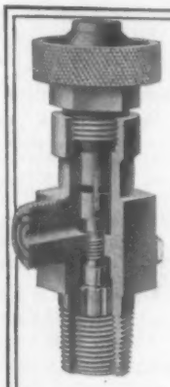

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Pressure utilized to retain contents.

Cylinder Valves of all types.

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High Pressure Tanks, Valves, Welding Appliances & Supplies
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NEW YORK

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Hints To WELDERS

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L. B. MACKENZIE, Editor

The Welding Engineer

608 S. Dearborn St., : Chicago

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Universal Oxygen Co.
Vulcan Process Co.

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The Linde Air Products Co.
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Vulcan Process Co.

WELDING RODS

Bierman-Everett Fdy. Co.
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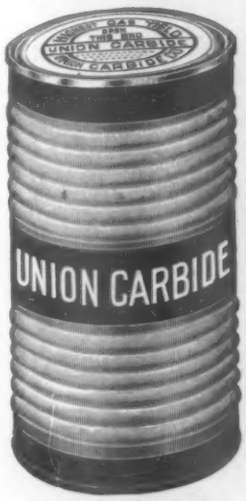

Packed in Blue and Gray Drums

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"World's Best Quality—Highest Gas Yield"

For Oxy-Acetylene Welding Plants

Contractors' Flare Lights, Torches and Private and Municipal Lighting Plants

"Union Carbide" is packed in 100-lb. blue and gray drums marked conspicuously, "UNION CARBIDE."

The following sizes are carried in stock in 100-lb. drums:

$3\frac{1}{2}$ x 2 in. —a large size.

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$\frac{1}{4}$ x 1/12 in. —finely crushed size.

Union Carbide in the Generator sizes above listed will be shipped direct to consumers from a **Union Carbide Sales Co.** warehouse at any one of the following points where large stocks are kept on hand:

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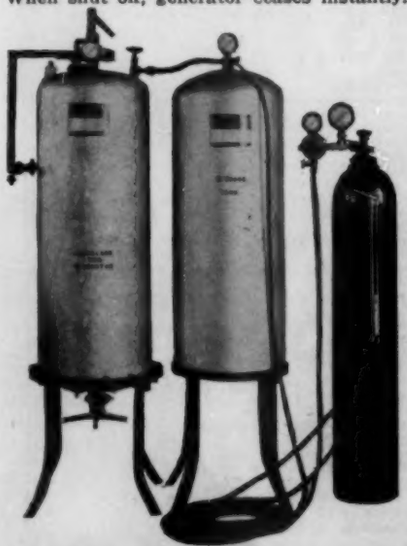

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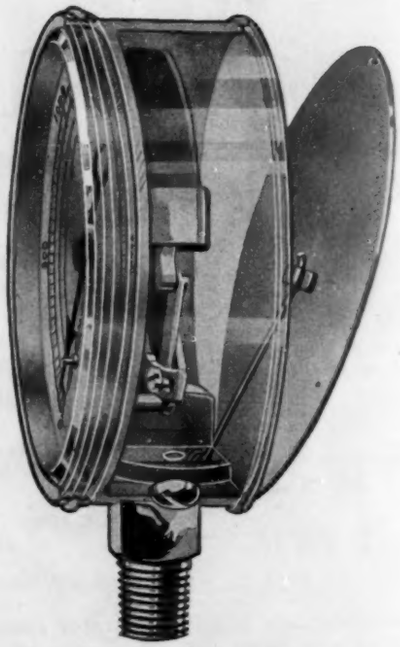

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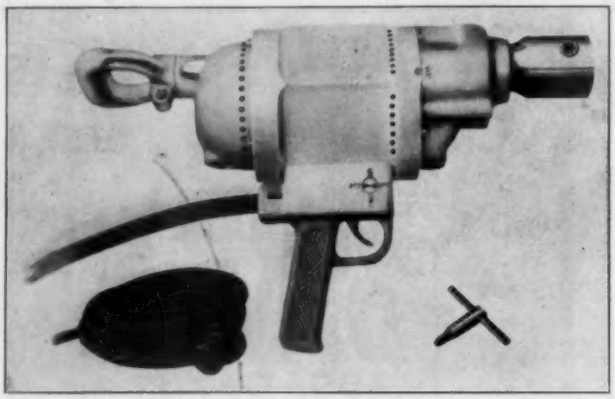

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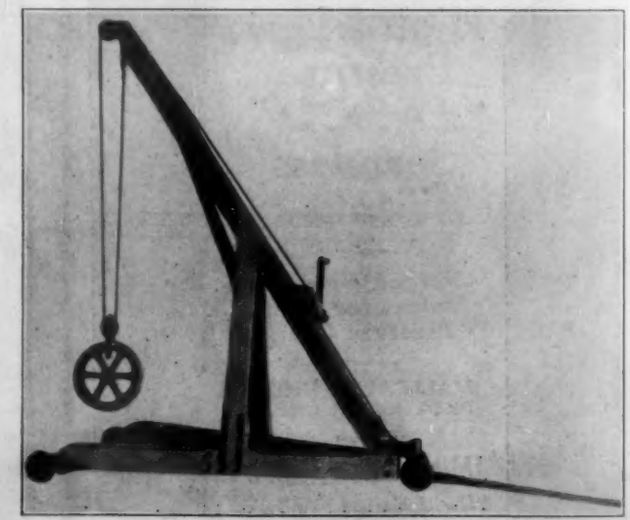

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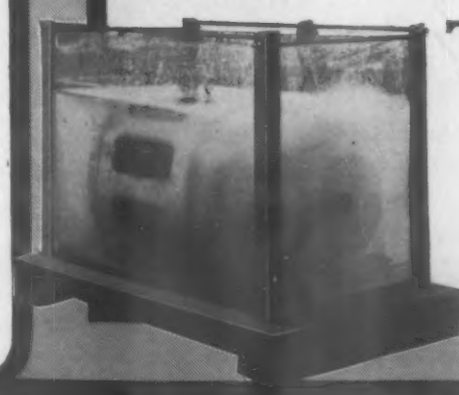

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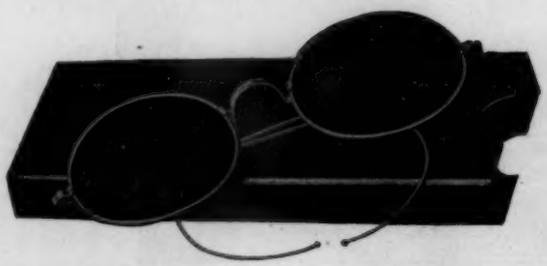

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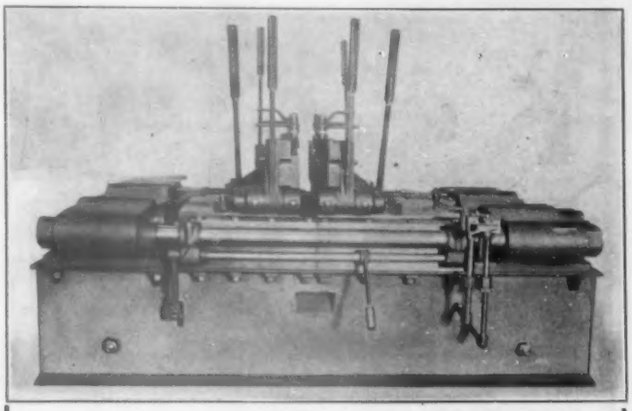

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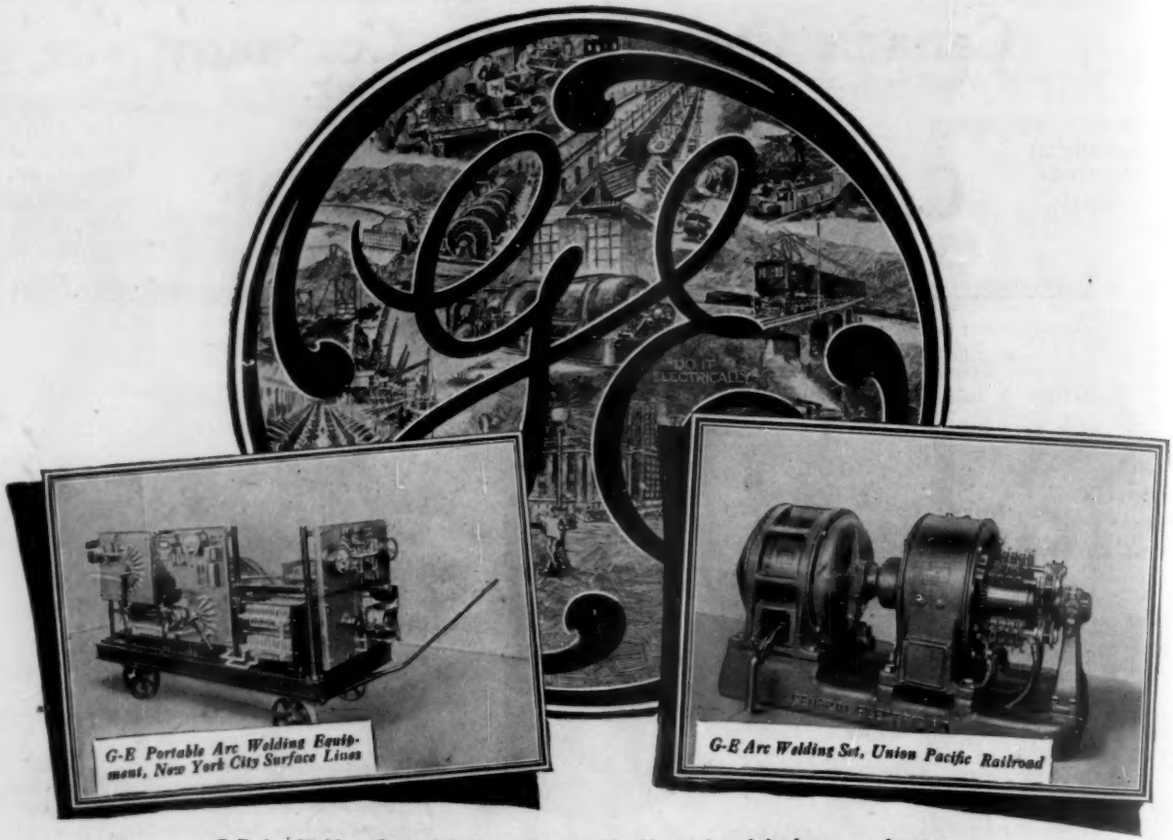

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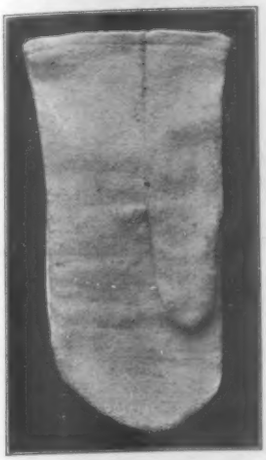

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Abnormal Business Conditions—
What we Are Doing To Meet Them

Chapter K.

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In Chapter "L", the next of this series, we will call attention to the remarkable work of the Linde traffic department, as a factor in Oxy-Acetylene progress.

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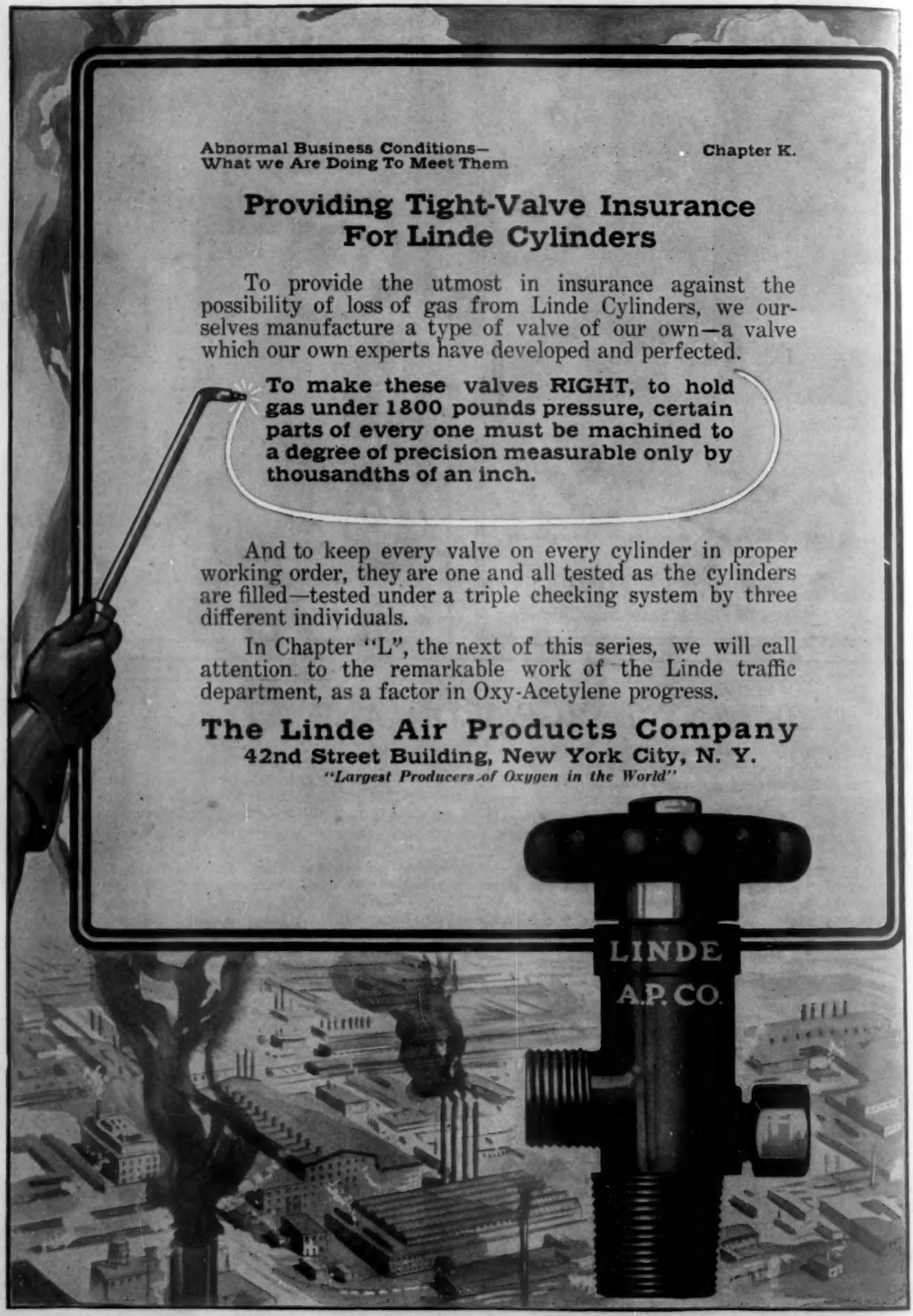


WELDING *of* LOCOMOTIVE ENGINE FRAMES *by the* OXY-ACETYLENE METHOD

A Practical Discussion of Method of Welding as Practiced in a Railroad Shop

By Nels Johnson

In the December issue of *The Welding Engineer* an article appeared on this subject. However, I believe, that the fact that one has already written on a subject and expressed his ideas and opinions about how to handle a certain piece of work, should not stop anyone else from writing on the same subject, providing their ideas are not identical.

Since I took up oxy-acetylene welding I have had opportunity to weld quite a number of locomotive engine frames.

The frames welded during the first months when welding was first introduced in the shop, not being taken in consideration, I have met with very good success, and I am confident of even greater success in the future.

Most welders have some peculiar ideas of their own. In fact, sometimes what one welder thinks is the correct and

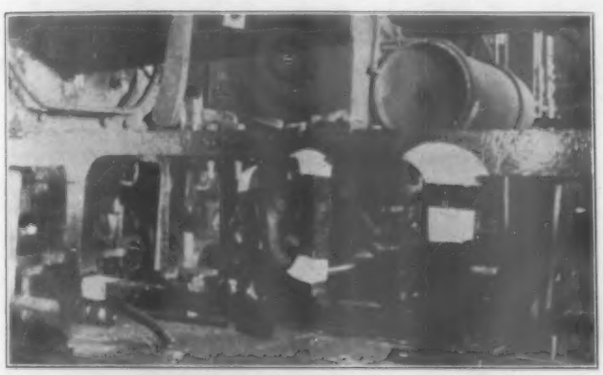


Fig. 1. Five Welds Were Made in this Frame.

proper way to handle a piece of work, another welder will condemn as altogether wrong.

I am not writing this to criticize any writer in *The Welding Engineer*, nor do I think I know it all, or claim to be an expert on this or any other kind of work.

I have met with very good success on engine frames and I am looking for ideas, believing that if other welders who are interested in their work, and who have met with success on any kind of difficult work would do likewise, we (the welders) would all be benefited.

By exchanging ideas and methods, will in my opinion, bring us to the best and only method. There can be only one right method, all others must be more or less near right.

Welding Material.

The frame welder will soon find that all frames are not made of the same material. Some frames are forged from iron, others are forged from soft steel, and still others, and most of them, are cast steel frames.

The material in the steel frames is sometimes found to be very hard. Care must be taken not to burn the steel as it will not stand the heat that soft steel or iron will stand.

I have found in my experience that a good Swedish iron filling rod, such as supplied by most, if not all welding companies or dealers in welding supplies, will furnish the best welding material for all frames, steel or iron, for reasons which I will state later.

The size of the welding rod may not make any material difference. I, for my part, like to have two ¼ rods in my hand when welding frames or any other heavy work. Two ¼ rods will melt faster than one heavy rod, and this saves time and work.

Preparation of the Weld.

Causes of failures are many and the welders must guard against them from the start.

It does not pay to try to weld a frame without removing such parts that will hamper the welder in making the weld,

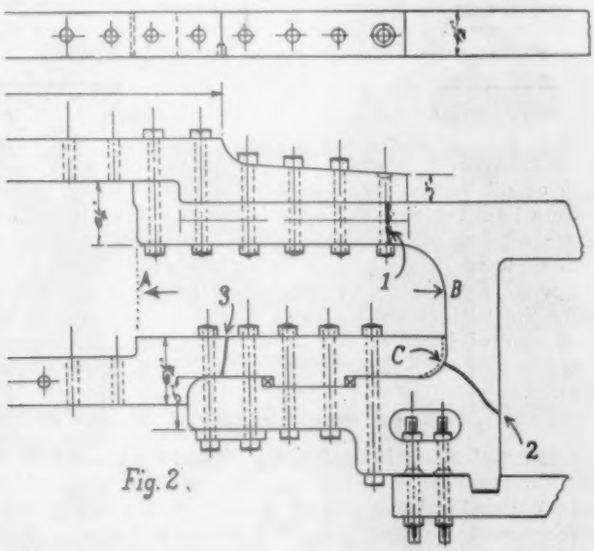


Fig. 2.

if it can be taken down without going to unreasonable expense.

Next the broken ends of the frame must be forced apart in order to give proper allowance for expansion and contraction. That is between ¼ and ⅜ inch. As a rule, a good screw jack properly placed will do the trick, but some times the opposite rail must be heated in order that both top and bottom rails of the frame may expand and contract at the same time when cooling. Fig. 1 shows a frame on which five welds are made. There is nothing unusual about this job. As seen, it was quite easy to get allowance for expansion and contraction on all the welds, the whole section of the frame being loose. The pedestal shows two welds. On account of an old broken weld which had to be cut away, a piece was forged and welded in its place.

Fig. 2 shows a frame broken in three places, 1, 2, 3, the

top rail (1) being broken in the bolt hole. Break 1 was first welded by placing a good screw jack between the cylinder casting A and the pedestal B. The break was opened 3/32 inch. When cool it came back right to the mark.

Next break (2) was welded, the same amount being allowed for expansion. When welding the bottom rail I found it more practical to remove a few bolts, thus making the piece loose, then to get the needed expansion by heating the top rail. By cutting off the end of the broken rail as shown at C, I slipped the piece back to the pedestal 3/32 inch. There being no force on the piece whatsoever 3/32 came out all right for length. Had the frame been jacked apart as when welding the top, I would have given 1/8 inch for expansion on that size frame. The frame being repaired once and made heavier than shown in sketch, which is taken from blue print, was 4 by 6 when weld was made. When the frame was cool a wedge shaped line was made and welded in the opening at C, making it as good as ever.

It is difficult to lay down a rule as to how to get the amount needed for expansion and contraction and it is not necessary. The operator will always find a way. Be it enough to state that it is of vital importance, and absolutely necessary, that the frame to be welded is set free to expand when heated and to contract when cooling, 3/32 to 1/8 inch being as a rule the proper amount.

After the break is thus jacked apart, or other allowance made for expansion, the frame should be cut as shown in Fig. 3. Enough should be cut out to allow the operator to work his torch and filling rods freely on both sides.

After this is done all iron oxide should be chipped off,

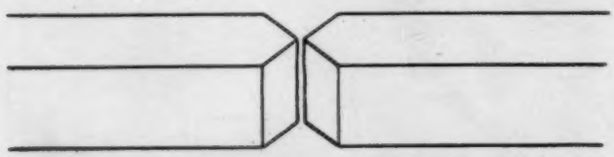


Fig. 3. Correct Method of Beveling Frame.

a brick furnace built around the weld, and the frame heated with an oil burner.

On a light frame, a weld may be made without preheating frame with an oil burner.

In that case, start heating at bottom on both sides with the welding torches. It requires only a few minutes to bring the bottom of the frame to red hot. The rest will take care of itself as the weld is progressing. When a frame is welded in this manner, 1/4 inch is sufficient for expansion.

The Welding Operation.

When preheating is used and both ends are red hot, the brick furnace should be removed quickly and welding started immediately, one operator on each side of the frame, starting at bottom and working towards the top. Both sides of the weld and inside or at the center should be kept a little high, in order to run off all iron oxide and other impurities sometimes found in the material of cast steel frames.

When the bottom is built up heavy enough to stand hammering the metal thus welded in should be hammered and packed together by the aid of a fooler made for the purpose and a light sledge. Care should be taken not to lose the heat. The welding should be resumed immediately and another inch welded in. A short stop should be made again for hammering. The fooler used should be shaped so that it can be worked freely all around and on all sides, and round enough not to make any marks. In other words, the metal should be hammered and packed firmly.

The frame should be reinforced on both sides of the weld about 5/8 inch and left 3/8 to 1/2 inch wider on each side, when practical.

After this is done, the part welded being red hot, welding should be continued as before. Hammering should be made about every inch welded and the bottom kept hot until finished.

When the weld is finished, both sides cleaned off with the torch, the whole weld should have a uniform heat. Light hammering may now be done to give the weld a smooth surface.

This will not make it any stronger, but it will look more like a mechanical job if it is smooth and even all around.

The jack, if used, should then be loosened a trifle, and as the frame is cooling and contracting the jack should also be loosened a little at a time until the heat does not show any more. In other words, when the red heat has disappeared the jack should then be taken down and the frame allowed to cool and contract freely.

Causes of Bad Results and How to Avoid Them.

I do not know very much about chemistry, hence I will not try to use chemical terms. Many very able writers have ventilated this subject from a chemical point of view in *The Welding Engineer* from time to time. I will merely try to explain this matter as it appears to me. The man on the firing line using the torch every day cannot help but form opinions and theories.

Studying his work he will discover causes of failures and improved methods.

When the operator meets with failures, as a rule the method, not the welder, is blamed. But the fact that no matter how many failures occur in a shop where frames are welded, some welds will hold and stand the test, should in my opinion furnish proof enough that the method is not at fault. If the operator makes a good weld once in awhile, he has yet to discover what made the rest break. There must be a reason. Any blacksmith will accidentally make a good chisel once in awhile, but it takes a good mechanic to make a lot of chisels, and make them so that all of them will stand hard work.

One of the main causes of failures in my opinion is improper allowance for expansion and contraction. As stated above 3/32 to 1/8 is in most cases the proper amount. This may be hard to get and the operator after working hard to get 1/8, lets it go at that and welds the frame. When heating the ends are free to expand and will expand or lengthen. But when cooling it is not free, the ends are welded together. What then will take place? The rail welded would become 1/8 inch shorter than before or perhaps more as the case may be if loosened and allowed to cool.

Now it is not loose. The opposite rail is longer and besides, the frame is bolted tightly to other parts of the locomotive.

Something must give. If there is nothing else that will give the welded rail must contract or lengthen as it is cooling and that will take place in the weld which is hot. It will pull together as a rule and spring the opposite rail and other parts to which the frame is bolted, thus creating an awfully hard internal strain in the frame, which together with all jerks and bumps the engine receives when working, will cause the frame to break again sooner or later.

In this connection I wish to state that I believe the writer in the December issue of *The Welding Engineer*, Mr. Kopferschmidt, is wrong when he states in his article on frame welding: "After the frame is annealed and the metal brought to a bright cherry red, it should be left to cool for an hour. Then the jack is slowly released to proper size between the jaws and left there until entirely cool." Why leave the jack between the jaws for one hour after the weld is allowed to cool?

The expansion of all metals will increase by added heat, and contraction will take place when the heat is decreasing.

By leaving the jack between the jaws for one hour after

the frame is allowed to cool, it will prevent the frame or the jaws coming together as the frame is cooling. If set free, the frame would in one hour contract at least two-thirds of the full amount given. When this cannot take place the frame must lengthen that much in the weld. The weld is put in a severe pulling test before the metal is cold and hard, and it will weaken the weld because it will pull it apart.

Anything to be welded, a frame or any other thing, should, when at all possible, be set free to expand and contract. If this is not done it may be a cause of failure, or a break elsewhere in the frame and should by all means be avoided.

Much has already been written about the bad results caused by burning excess oxygen or acetylene gas, and the welder is taught from the start to use a neutral flame to avoid bad results from this cause. Excess acetylene is easily detected in the flame or cone, but excess oxygen is not.

While at work welding, the oxygen valve of the torch may accidently be opened a little and excess oxygen used. If working from pipe line the oxygen pressure may vary a little and cause the same result without it being noticed in the flame by the operator. Excess oxygen as well as excess acetylene gas is easily detected in the weld and should always be avoided. By working the torch too long on one place, the metal will get too hot and absorb or combine with the oxygen in the air, causing in appearance the same foaming surface as when excess oxygen is used in the flame.

If the melted metal in the weld is covered with a boiling, frying foam, something is wrong.

The flame should be adjusted immediately and if found to be right, welding stopped a moment to allow the metal to cool a little. If welding on a frame it gives the operator an opportunity to heat the bottom of the frame in order to hold a uniform heat. One cannot make a good weld without sufficient heat to fuse the metal, both the surface to be welded and the filling rods, but excess oxygen as well as excess heat should be avoided as much as possible.

As both steel and iron have a great tendency to combine with oxygen when in melted state, the process of welding should progress rapidly.

In other words, the melted metal should not be exposed to the air more than necessary.

If excess acetylene gas is used it will carbonize the metal and make a hard and brittle weld. The melted metal appears as though it was mixed with sand, or very near the same as carbon steel appears under the heat of the torch.

A good, soft iron will stand more heat than steel without injury. It will not oxidize as quickly and therefore furnishes the best welding material on engine frames.

A good, soft steel will, if not overheated or oxidized, furnish a good welding material, but oxidization will take place to some extent no matter how carefully guarded against. It is better then to use a material that will stand high heat without injury.

Another common cause of failure is neglect to heat the surface to fusing point before adding more metal from the filling rods. It is simply filled in, not welded. It may look all right to the untrained eye and be covered up, but in order to weld both must be in melted state.

A good way to test one's work is to take the cutting torch and cut through the center of a broken frame weld. By watching closely at the bottom of the cut as the iron oxide is running out, patches covered up, holes or cracks, can be seen very clearly.

Two operators working one on each side of the frame should always be used, and if there is a third man to spell off it is better, but both sides should be built up even. If one side is easier to handle than the other, or if one man is a faster welder, it makes no difference. Both sides should be built up even and finished at the same time. Even heat should hold as much as possible, and when a weld is started it should be continued until finished without allowing the frame to cool.

Oxy-acteylene welds on engine frames are called a failure in many places, but those who think that have another think coming. If applied by experienced men it is proven to be very successful.

A failure will, of course, happen some time no matter how well the work was done, but it must be borne in mind that the frame broke before it was welded at all, and any other weld will sometimes let go.

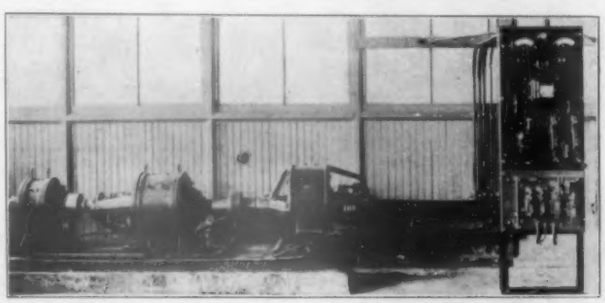
No weld can be made and guaranteed never to break again.

CONSTANT-CURRENT CLOSED-CIRCUIT ARC WELDING SYSTEM.

Arc welding practice as it exists today is based on operation of arc from constant-potential circuits, and since arcs operated under these conditions are unstable, it is necessary to connect in series with each arc, a ballast resistance.

In the early days, comparatively high voltage circuits were used and enormous quantities of energy wasted in resistance. Later, as arc welding became of greater industrial importance, generators were constructed especially for the purpose, and the voltage was made as low as possible, until finally it has settled down to from 60 to 70-volts. Automatically controlled resistance which changes with the value of the current, permits the use of a lower voltage, but the arc still has the constant-potential characteristics.

A normal welding arc consumes about 22-volts. However, depending upon the operator or upon the work, it may vary from 16 to 28. Therefore, any voltage produced by the gen-



Self Regulating Welding Generator.

erator in excess of this, must be absorbed in resistance and wasted.

The constant-potential arc when operated in multiple with other arcs, requires a separate circuit from the generator end of the line, or at least from a point in the distribution system where the voltage regulation is close, otherwise the coming on and the going off of the various arcs will disturb the regulation to an intolerable degree.

On account of the expense of low-voltage distribution circuits for constant-potential arcs, practice has drifted toward the single-arc unit, portably mounted.

The Electric Welding Company, electric welding contractors who have been in electric welding business for nearly 10 years, developed in their practice a new system of arc welding, and in order to place this system on the market, organized the Arc Welding Machine Company as a separate corporation. The Arc Welding Machine Co. has perfected the system, now known as the constant-current closed-circuit system, which operates arcs in series.

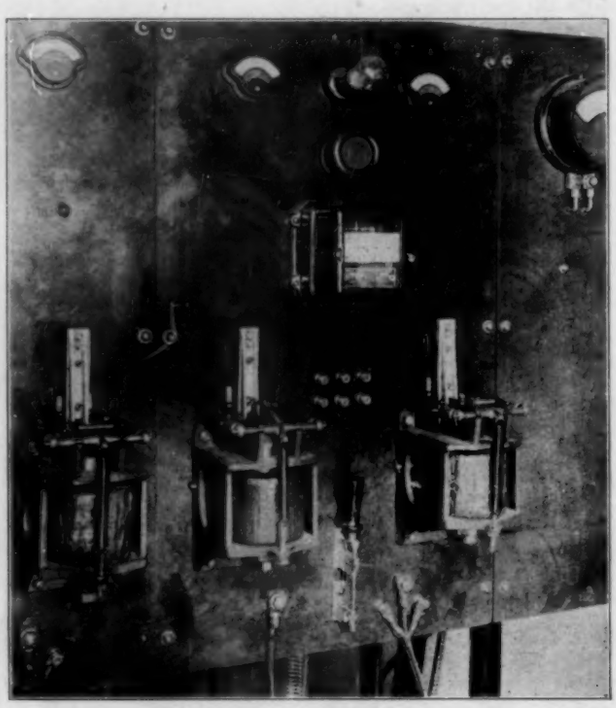
This method has all the advantages of series distribution, namely: the size of wire is uniform throughout the system and carries a uniform current, independent of the length of the circuit, as well as of the number of operators. The cir-

cuit is simply a single wire of sufficient cross-section to carry the current for one arc run, from the generator to the nearest arc, from there to the next, and so on back to the generator. Wherever it is desired to do welding, a switch is inserted in the line, and a special arc controller provided with suitable connections plugged in across the switch, whenever work is to be done. These controllers may be portable or permanently mounted at the welding station.

The generator is a special machine and consists of two units. The generator proper which furnishes the energy for welding; and the regulator, which automatically maintains the current at a constant-value. The regulator is excited from a separate source and by varying its excitation with an ordinary field rheostat, the main welding current may be set at any value within the range of the machine that is desired, and once set it will automatically maintain that value.

Each arc that is operated on the system is equipped with an automatic controller, which serves two essential purposes.

1. It maintains at all times the continuity of the circuit, so that one arc cannot interfere with any of the others when it comes on, or goes out of, the circuit.



Automatic Arc Controller.

2. It controls automatically the heat which can be put into the metal of the weld.

The current through the arc, together with the size of pencil, determines the flow of metal from the pencil, and this current is adjusted by shunting any desired portion of the main current around the arc. The regulation characteristic of the arc being adjusted by a series parallel resistance, which is patented.

For a given flow of metal through the arc, the temperature of the metal is determined by the length of the arc, that is, by the voltage. With this controller, the length of the arc limited by the voltage is adjusted to suit the work and the operator; and if exceeded, the arc is short-circuited automatically, and remains short-circuited until the welder is ready to begin again.

Provision is also made for stopping the arc at will without lengthening it. Therefore, with this system it is impossible to draw a long arc and burn the metal, and most important of all, the arc is not broken when the welding operation is stopped, but is killed by a short-circuit which is placed across it.

Stopping an arc by short-circuiting and limiting the heat production in the same way is also patented. A great step in advance has been made by short-circuiting the arc instead of breaking it; because it is impossible to avoid leaving a crater with pin-holes by any other means than reducing heat of the metal, and this is the most effective method of doing it.

On account of the fact, that the arc heat is automatically controlled and limited, it is possible to use a lower grade of labor in welding operations with this system.

The number of arcs that can be connected in series is limited only by the voltage; and up to the present time 12 is the maximum number for which machines are constructed.

NEW WELDERS' ASSOCIATION.

A new organization known as the American Acetylene Welders' Association, Branch No. 1, has been formed at Jackson, Mich. On April 28th a meeting will be held at the Tuller Hotel, Detroit, Mich., for the purpose of organizing a second branch. Meetings at Jackson are to be held the first Wednesday of each month at the Y. M. C. A. club room. At each meeting a paper will be read by a member or a vistior. At the next meeting Mr. B. Kopferschmidt, the first president of the Branch, will read a paper on welding high speed steel. Mr. A. F. Dillon, Y. M. C. A. Building, is secretary.

The charter members of the new association are as follows: B. Kopferschmidt, president; J. H. McIntosh, treasurer; U. J. West, E. G. Cady, W. M. Backus, A. Lewis, A. Young, S. Goldfarb, C. Belcher, S. Dennis, Geo. V. Nord, J. Ennis, C. Briggs and A. F. Dillon, secretary.

NEW DETROIT COMPANY.

A new company has been formed at Detroit under the name of the Oxy-Acetylene Equipment Company, to handle welding apparatus and equipment of all kinds. The company is under the management of C. H. Dockson, one of the oldest and best known apparatus salesmen in the country.

NEW APPARATUS COMPANY.

The Bradford-Ackermann Corporation, recently formed by A. H. Ackermann and C. C. Bradford, with offices in the Forty-second Street Building, New York City, announce that they have concluded arrangements with Ashton, Laird & Co., for the sole selling rights of their "Astra" high temperature gas apparatus and oxygen welding appliances, manufactured from the designs and patents of E. Raven Rosen-Baum, the well known consulting engineer on high temperature gases.

In addition to the extensive line of the various oxy-acetylene welding appliances, of proven merit and superiority, there will be marketed a new and standardized line of oxy-illuminating gas apparatus exclusively manufactured by this company. In this process either natural or artificial illuminating gas, direct from the town supply, is substituted as a supporting gas in connection with oxygen, and recommended for economy and efficiency, on a number of classes of work where its specific temperatures are especially adapted.

These new appliances produce a proper neutral flame and permit an extraordinary simplicity of operation. The process has proven to be of considerable technical value on a variety of work and is already domineering various fields, such as lead burning, etc.

Bulletins of the new appliances are now on the press.

EXPANSION AND CONTRACTION IN WHEELS AND HOW TO COMBAT.

By J. R. Waters.

In the welding business, as in all others, the man who wants to succeed must recognize the law of cause and effect. All sciences have no existance apart from the idea of law. The welder, to succeed, must recognize, and especially so, in relation to the above subject, the law of expansion and its reaction, contraction, and try to conform with this law to the best of his ability. Never forget it, or it will force itself upon your mind and job with maybe unpleasant force, just the same as if you forgot about the law of gravitation and walked off the roof of a 14-story building. Now there seems to me to be a tendency

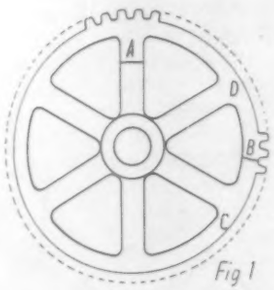


Fig 1

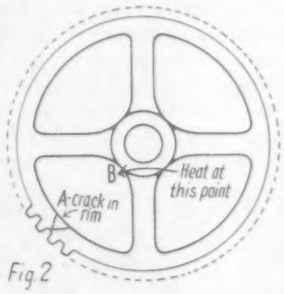


Fig.2

on the part of most welders who have written their experiences to neglect one important, and to my mind very important, fact regarding wheel problems. There are many contributors to *The Welding Engineer* who are, no doubt, clever and intellectual individuals. I myself have found many useful ideas from their articles on different subjects, and it is in appreciation of these ideas that I take up my pen and try to add what little I can to the problems which confront the best of us some times. Now the point I want to make, more than anything else, is in regard to the welding of the rims of the wheels. Every welder who has tried to weld a spoke in a wheel knows of the necessity of allowing it room to expand and contract, as a very slight strain set up in the spoke, when bound by the heavy rim, will show itself by the breaking of the spoke, as the strain is confined to that particular number, if the rim has not been heated. Not so in the case of the rim, however, as the strain is divided over a greater area, as will be seen by observing Fig. 1. Consequently the strain is not noticed so much as in the case of the spoke,

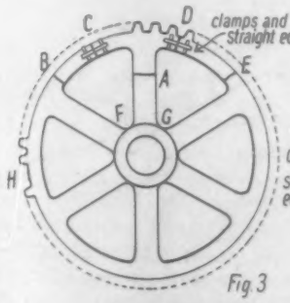


Fig 3

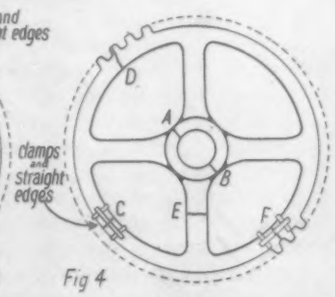


Fig 4

but distributing the strain does not eliminate same. Now referring to Fig. 2: A is a crack in the rim of the wheel. Now it is possible to weld same without any preliminaries at all and the job may stand up, but then again it may not. This is the only *luck* any welder may hope to have He may make the weld strong enough to withstand all the strain for the time being, and then in a little while the owner of the wheel will come to you and say, "the wheel has broken again." In the weld? Oh no, a little way off. Then with great pride and egotism you will point out to him, "our welds never break." I know, I have been through the mill. But to get down to business, it was largely the welder's fault that the wheel broke again, through not allowing for that nightmare of the welder, room for the contraction of the weld. Now I contend that the right way to do the job was to open the wheel at the point A sufficient to allow for the contraction at that particular point and my method is as follows: Heat the hub with the torch, or a coal oil torch, at the point B, and you will find that you can easily get all the opening you need at A, with a very slight heat at B. The amount of opening you need depends upon the thickness of the rim. You only need a little experience on different wheels of varying thicknesses to determine that. When you have what you think is enough opening proceed to weld rim. If you are working on job alone do not let hub get cold immediately, but jump up to it with your torch occasionally, as the other part of the wheel, being cold, soon takes away the heat. When nearly through with weld at A leave B alone and finish at A, and you will find that when cool there is no strain left in the wheel at all. Now on looking through back numbers of *The Welding Engineer* I find a number of drawings of wheels, and one in the July edition is by a strange coincident an exact reproduction in regard to breakage as one I myself had to repair, excepting one extra break. I accomplished the job in a lot different way than the one which was done in the illustration. I refer to the July number. My method was as follows: Referring to Fig. 3 parts broken A, B,

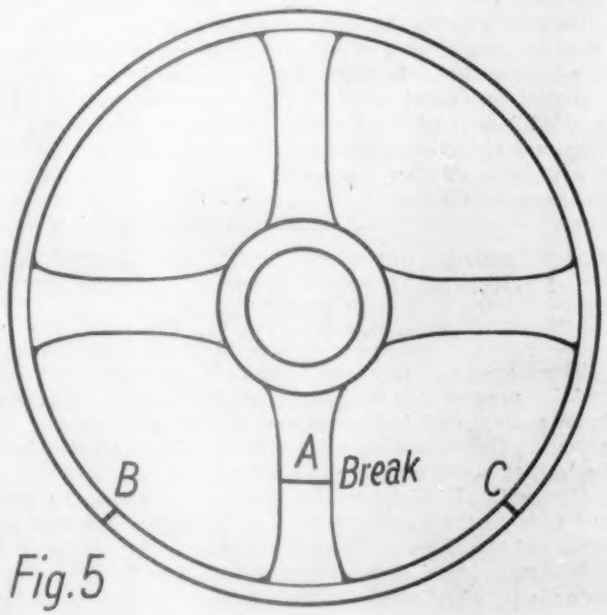


Fig.5

C, D and E respectively. I set the pieces back in their places by tightening a piece of welding wire around the whole outside rim of wheel, then I and another welder tacked points B and E, then clamps and straight edges were placed at C and D to control or keep piece from falling out of line when expansion takes place through heating of spoke. A was opened 3/32 inch and tacked on one side, then I turned over and burned out three parts way through, welded, turned over and remainder was burned out and welded and left to cool. When cool we found that we had just left enough open at A, as the parts C and D were exactly in line and fitting perfectly. Then as explained before, F was heated to give the necessary opening at C. That part, as you have noted, not being tacked, consequently being free to move, which was then welded. The same procedure was followed at points G and D. It then being quitting time and the wheel not being, as is usually the case, in the repair shop, the fact that a new pinion had to be made and other repairs done to the machine, we went home. In the morning when we came to work, we examined the wheel and found we had gaged the distance at C and D so well that the tacks at B and

E were not broken. The same procedure was followed at F and B, and G and E as explained before. Of course, the tacks being broken at B and E first, then the tooth H was built up and machined down. The wheel has been running on war orders and at high pressure ever since. Now there seems to be a little controversy over a wheel welded by W. B. Manning, in the December issue of *The Welding Engineer*. I would like to "butt in" and point out the way I would do the job. First, set up wheel, then tack at A and B, clamp points C and F as explained in last illustration, allow enough opening at E which is determined by thickness of section, to take care of contraction of hot metal at that point. Tack one side, turn over weld as spoke as in last wheel and allow to cool. Then weld A and B; after those are welded, all you have to do is to treat other breaks D, F and C as separate breaks in rim and follow procedure outlined in proceeding parts of this article. I could go on explaining different jobs on wheels for months, but when you have once grasped the idea they are merely a matter of repetition. Before closing I would like to point out a method of getting sufficient expansion to weld, say a wheel with only one spoke broken, referring to Fig. 5. Heat a section of rim at B and C until you have enough space at A to allow for contraction of weld at that point, weld same, keeping the heat on B and C until weld at A is nearly finished, then take heat away and finish weld, and then let wheel cool off. Of course, there are some wheels which, owing to their small diameter, combined with great weight and consequently heavy spokes and rims, that it is not possible or I should say not advisable to weld spokes by above method. In these cases preheating is desirable from the gas consumption standpoint, but wherever possible and in nearly all cases of rim breakages it is good policy to try and overcome the contraction and expansion problem by local heating, which in all cases is governed by the nature of the job and the extent of the break.

SOME MORE USES OF THE OXY-ACETYLENE BLOWPIPE IN THE LOCOMOTIVE BOILER SHOP.

By B. Kopferschmidt.

There are some people who claim that the oxy-acetylene welding process is in its infancy yet, and that we all have to learn a great deal before we can get the full benefit of the process. Others are claiming that they know all that is to be learned about cutting and welding.

Personally, I belong to the class that is willing to learn and advance the welding process as far as possible, as there is no end to the possibilities of the gas welding device.

In August, 1916, I wrote an article in The Welding Engineer about "The Oxy-Acetylene Welding Process in the Locomotive Boiler Shop," and I thought that I covered all that could be said about this class of welding. However, during the past seven months, I learned a great deal more and today the operations performed with the oxy-acetylene blowpipe in our boiler shops are greatly increased. These new successful operations not only increased our saving in money over the old methods, but they accomplished a far greater saving in dispatching our shopped engines sooner than with the old methods.

There are four cylinder head covers on each locomotive that were made by the boilermakers. These covers are made of No. 11 or No. 12 gauge sheet iron. The mechanical process of making these covers consisted of laying out the sheet iron, which was then pressed in a form and hammered to suit the size. Then it was trimmed off at the edge and a hole drilled in the center. The cost of this operation is about $5.00 apiece, but the greatest trouble was that the boilermakers could not supply all the necessary covers, as they were too busy with other more important work.

Here is where the boilermakers were relieved and the acetylene blowpipe employed to make these covers, for only 62 cents apiece. The method of making these covers was as follows: The proper size rims, about four inches wide, were cut and welded at the seam, then round tops were cut to fit the rims and welded all around. The best feature was that with the acetylene method we could supply all the necessary covers, also a good stock.

When a set of locomotive flues has to be taken out and the front sheet is not to be removed, there is a practice among boilermakers of reaming out one flue hole a little larger and through this hole the 365 or more flues are taken out. I have seen times when a set of flues were so thickly coated with scale that it required many days and nights of hard labor to remove these flues through the enlarged flue hole. Even under favorable conditions this operation is regarded as the hardest job in boilermaking. However, one of our progressive boiler shop foremen at St. Thomas, Ont., suggested the aid of the acetylene blowpipe to cut a round hole in the center of the flue sheet, as per Figure 1, with the cutting blowpipe.

Through such a hole all the flues are removed as fast as they can be handled out of the boiler, then the same piece that was cut out is bevelled on both edges to a 45 degree angle and welded back in its place. This operation cost one

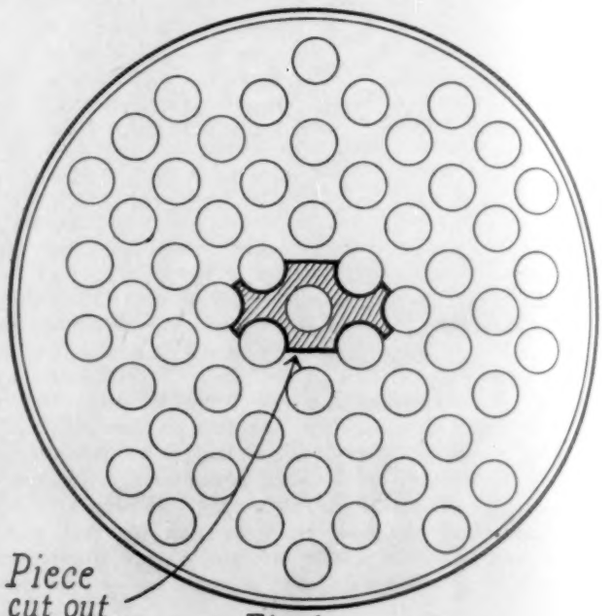


Fig. 1

dollar and the saving is greater than any other welding or cutting operation performed in the boiler shop.

There are some experienced boiler welders who are claiming overhead welding on whole crown sheets is not only practical but easy. However, I found this operation without standard blowpipes too complicated and expensive, and I felt justified in discouraging the overhead welding on long seams, and limiting the overhead welding to small patches.

Recently I found an old blowpipe that was used for machine welding. The head or nozzle was not bent to any degree, but was straight in line with the handle. As the whole handle was about 8 inches long and too short for any hand welding, I welded a 6-inch extension in the middle. Then I was looking for some operations where I could employ this blowpipe and found it successful in overhead welding In welding the first crown sheet, I found that this style blowpipe eliminates all the hardships experienced with the standard makes, and the cost is not much higher than the horizontal or vertical boiler welding.

We had a great many old riveted side sheets in the fire box where there was hardly any caulking edge left. These seams were a continuous source of expense in maintenance

and loss of time in the round house, almost at end of every trip. Although the rest of the side sheet was in fairly good condition, yet there was a common practice to remove these sheets and replace them with new ones, at great expense and loss of time. However, with the aid of the oxy-acetylene cutting and welding blowpipes, these sheets are saved and the bed seams eliminated with the following method: Cut out a straight line on the center of the rivets from flue sheet to door sheet flanges with the cutting blowpipe. Then with a pneumatic air hammer bevel both edges to a 45 degree angle, including the half rivet holes. Then remove two rows of staybolts on top and one row at the bottom of the seam. Then clamp both top and bottom sheets to keep them level, about every six or eight inches apart. After this preparatory work is done, tack the line of welding between clamps. Care should be taken that every tack made should not be directly above the staybolt hole, but between two staybolt holes. Then start welding from the center to one end, and again from the center towards the other end. When the welding is finished, the fire box has an entirely new appearance.

The cutting blowpipe has also advanced and has increased its operations in the boiler shop.

With the mechanical process it costs the railroad on a piece-work basis about 6 cents to remove a rivet from a boiler. With the acetylene cutting blowpipe, rivets can be removed successfully, without damaging the sheets, for one cent apiece, with the exception of the mud ring rivets. These rivets have to be drilled out and removed with the mechanical process.

The method of cutting out rivets on a fire box or boiler with the blowpipe is as follows: If the head is flat on each side, then concentrate the pre-heating flame on the center or rivet until the metal starts to fuse. Apply then the blower and blow a hole through. By this time the whole rivet will become a dark red, while the sheet around the rivet will remain black. This feature of difference in colors should help the operator to burn the rivet material only, by moving the nozzle around the center until all the red hot metal is blown through the sheet. Thus a bare round hole is left on the sheet. If the heads are round, then cut off the heads first, then follow the above method to cut the internal part of the rivet.

If we can increase these welding and cutting operations in the boiler shop at the above rate, then the value of the oxy-acetylene blowpipe will be the greatest in a railroad shop. It is a well known fact that it is the boilermaker that keeps our locomotives the longest time in the shop, and if we can shorten his labors with the aid of the blowpipe, so that locomotives should be out of shop sooner, then this wonderful welding and cutting device will accomplish a great saving.

CUTTING STEEL RISERS.

By A. Krebs.*

Very often the question is asked by cast steel foundries, how much does it cost to cut risers. The answer is a pretty complex one. There may be holes and sand in the risers, the outside of the riser may be covered with sand and scales, the operator may be a poor one, or he may be forced to do the cutting in a very uncomfortable position so as to interfere with an easy and unobstructed movement.

As to operators, mostly unskilled labor is employed and when they are broken in and just start to get on to it—and then ask for a raise in wages—they are discharged and the game starts in over again. Foundries, however, begin to see that a careful and conscientious operator is worth good wages. The saving in oxygen alone may pay for all that he gets out of it.

When risers are sawed off mechanically, great care is taken to line up the castings right, to remove all sand and scale, and to see that a skilled mechanic is at hand, but when it comes to gas cutting, the operator is often expected to be an acrobat, and do besides the cutting, some aviator or snake stunts.

Now, everybody knows that a good cut needs not only a reliable cutting torch but a good steady hand and an unobstructed movement.

Furthermore, sand and scale should be carefully removed, not only on top but especially on the bottom of the riser. Otherwise, the oxygen strikes at the bottom of the slot against a scale of oxide which it can only penetrate with difficulty, and the burnt material instead of blowing straight down the slot, blows out partly sideways or blows even back. Of course then the lower part of the cut looks ragged.

In case of heavy cuts, 8 inches and more, it is essential to do a little special cleaning. The cut will then be much smoother and will save in labor afterwards.

Consulting Engineer, Boston, Mass.

The following table shows a few tests made under ordinary conditions in a big steel foundry. The cuts were made with a cutting torch of the General Welding & Equipment Co., Boston. The readings were made by the officials of the foundry concern:

Test No. 1 applied to cutting regular castings just as they came along. It represents the regular work of an operator in a foundry. Cleaning of the risers was of a very superficial kind, the operator knocking off sand and scale with a hammer just to get the principal dirt off. The readings were taken before and after the 40 cuts had been made. They include, therefore, every waste of the ordinary way of doing things.

Tests No. 2a and No. 2b were made on a wheel rim 1⅝ inches thick at the outside rim and up to 2½ inches thick in the center. No. 2a was a cut with one of the latest tips of the General Welding & Equipment Co., for oxy-acetylene designed to cut up to 3 inches. No. 2b was a cut made with oxy-hydrogen. The metal was clean and the cuts fine.

Test No. 3 was made on a clean riser. The cut looked as if cut by machine. This shows what good cleaning can accomplish.

Tests No. 4-7 were cuts on risers of a 10-ft. high fly wheel. The risers were only slightly clean and the operator had to do his best to get in a comfortable position for cutting. Of course for cuts of 10 inches to 16½ inches length, the operator should have all the comforts of a solid stand and of free movement, but in this instance, conditions were not ideal.

Nevertheless, the cuts were good, the risers dropped right off and the consumption of oxygen was remarkably low. This goes to show that much more could be attained if the set up had been more favorable. Furthermore, it must be stated that one or the other riser showed a hole which however did not stop the operation to a greater extent and that the operator was ordered to cut slow to guarantee a dropping off of the riser.

In a later issue I will give some practical figures about heavier cuts.

Test No.	Shape of Cut	Number of Cuts Made	Total Square Inches Cut	Total length of Cut Inches	Average Thickness of Cut Inches	Total Oxygen Consumption Cu. Ft.	Oxygen per Linear Foot Cut Cu. Ft.	Square Inches Cut per Cu. Foot Oxygen	Square Inches Cut per Minute	Linear Inches Cut Per Minute	Time Minutes
1	Different shapes, ⅛" thick	40	615	248	2.5	248	.....	2.84	.....	.....	.....
2a	Wheel rim, 1⅝"	10	94.5	54	1¾	8	1.78	11.8	22.5	12.96	4.17
2b	to 2½" thick	10	100.6	57.5	1¾	10.4	2.17	9.67	18.3	10.45	5.5
3	6½"x 8 "	1	52	8	6½	14	21	3.7	27.1	4.17	1.92
4	5 "x10 "	1	50	10	5	18	21.6	2.78	20	4	1.5
5	5½"x15½"	1	85.25	15½	5½	34	26.3	2.5	22.8	4.14	3.75
6	5½"x15½"	1	85.25	15½	5½	28	21.6	3.04	26.2	4.77	3.25
7	5½"x16½"	1	90.75	16½	5½	32	23.3	2.84	27.9	5.08	3.25

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Copies to prospective advertisers	85
Copies to other trade papers, correspondents, etc.	60
Copies mailed as samples to prospective subscribers	1,319
Copies for office use	10
TOTAL	4,100

VOLUME 2. APRIL, 1917 NUMBER 4.

Doing Your Bit.

IT is a privilege of the citizens of this country to disagree with those in power, criticise them when their actions do not jibe, publicly state what should have been; in fact we agree that we may at all times disagree—this in ordinary times. But now we are all agreed on one thing, solidly behind our President, we will do all we can to aid our Country. We cannot do less than give all we can to the service of this Nation.

Whether this service should be at the front or in the Navy or right at home depends greatly upon our fitness but surely all in the welding industry will be able to say that their bit has been done the best possible way.

Men familiar with the oxy-acetylene process of welding and cutting will find plenty of opportunities in the service. Skilled workmen will be needed at the front and still more men will be needed in the factories turning out munitions. Doing your bit right now may consist of making a better welder of yourself, preparing for harder work to follow.

Trade Paper Misinformation.

IN a prominent weekly engineering magazine appeared a heading leading one to believe that oxy-acetylene tanks were extremely dangerous. The body of the article related the accident of an oxygen cylinder which had contained a perfect mixture of hydrogen and oxygen, an occurence which was perfectly proper to publish but which certainly should have been studied a little closer by the editor before his title was written.

In a monthly magazine we note a series of "practical" welding articles, the first of which states that acetylene should not be allowed to generate over thirty pounds pressure. Most assuredly it shouldn't, as we all know.

There is little we can do except protest each time in the hope that eventually they'll stop doing it. Harm most certainly comes from this misinformation.

And, just to prevent our being hoisted by our own petard, we want to say in advance that errors are just as likely to creep into this paper as in any other. But our readers are so familiar with welding subjects that we expect we should quickly know about them; and information of this character is doubly welcome.

Mobolizing.

THIS country has entered upon the most momentous enterprise in its history. Preparedness is a word which has been bandied about for many months, but at last we are face to face with grim war.

There are some who would like to believe that this war is to be principally a loosening of our national purse strings, and that none of the honors and griefs of actual warfare will be brought home to us.

Now, that we have gone to war we must prosecute it vigorously, with cash, with munitions and supplies and with fighting men. Americans have never been put in the position of *buying* protection and we are not going to begin now. We are going to send the flower of our youth to Europe, there to uphold the teachings and splendid traditions of a great republic.

What Will You Do?

THE large army we are now recruiting and training will require the services of many thousands of trained mechanics, men who can do things. Among the skilled workers who will be needed are welders. Are you willing to serve your country for the period of the war? If you are, write the editor of The Welding Engineer today.

Business Magnanimity.

A CERTAIN big corporation, says the Wall Street Journal, was fortunate some years ago in getting a contract for a long period of years for raw material from a smaller corporation. It came to pass that prices of labor advanced sharply, so that the corporation which sold its raw material to its big client was making little or no money on its contract. Then the big corporation said: "You are not making any money out of the goods you sell, whereas we are making more money than we have ever made on our finished products. We'll do the square thing and pay you more than you are legally entitled to." This is the understanding of Wall Street interests. The big corporation referred to in court actions as merciless and contemptible is the United States Steel Corporation. The little brother benefited is the Pittsburgh Coal Co. Such things do not happen every day.

Welders Wanted for the Army and Navy

Experienced welders, both oxy-acetylene, electric, Thermit, etc., will find plenty of opportunities to serve their country. If you are willing to do your bit write the Editor of The Welding Engineer today. Give age, weight, state if a citizen and if married, experience, etc. You may be needed in the army or navy, or you may be needed in one of our munition plants. *Every citizen has a duty* to perform and this means you. Register with The Welding Engineer today and the information you give us will be filed with the proper authorities immediately.

OXY-ACETYLENE WELDING *in* REFRIGERATING APPARATUS

By M. Keith, Dunham

PROBABLY in no other field of industrial use is the proper application of oxy-acetylene welding of more value than in that of refrigeration. Ammonia leaks are to be avoided both from the standpoint of cost and hazard to human life. The pressures used are not, so to speak, high, particularly in these days of carbonic acid gas, oxygen, hydrogen, etc., which are commonly shipped in containers at pressures from 1,200 to 1,800 pounds per square inch. Refrigerating plants employ considerable pipe which must be jointed together by threads, flanged joints, or welding; and it would seem that the widest possible use of the oxy-acetylene process would by this time have been taken advantage of by the refrigerating industry.

It is because of the apparent simplicity of the process that disappointing results are sometimes realized. Elementary principles are many times lost sight of, and in viewing the results engineers are likely to place the blame of a faulty weld upon the process rather than upon its incorrect application.

Oxy-acetylene welding is not the patent medicine "cure-all" of the refrigerating world. It is, however, a remedy for many of the ills resulting from former methods of construction of pipe and pressure vessels, if it is intelligently taken.

Oxy-acetylene welding is a fusion process. To bond a seam, joint, or break, a flame of something over 6,000 deg. F. is played upon the metal until it melts and flows together. When any metal is melted a physical or chemical change, or both, takes place in the weld, or in the line of metal adjacent to the weld. Iron or steel which has been rolled or forged is of coarser grain in the weld, more like a casting. In addition the weld may absorb gases, it may oxidize, or it may decarbonize.

Importance of Apparatus.

A realization by the constructor of refrigerating apparatus of the difficulties encountered in the application of the oxy-acetylene flame to steel welding, and particularly to that which is subjected to tension is essential. Without attempting technical explanations or discussions, let us first consider the apparatus itself, the importance of the quality of which cannot be over-estimated.

The welding torch is an apparently simple tool of two brass tubes terminating in a tip from which comes the flame. The other end of the torch has upon it connections for two hose, which lead back to regulators controlling the pressure of the two gases, oxygen and acetylene. But while the torch looks simple it might be said that hundreds of thousands of dollars have been spent upon its development with a view of constructing one which will deliver the right proportion of gases in the correct mechanical shape of flame. Too much oxygen in the flame means a weld badly burnt, and therefore, deficient in strength. Even a flame too rigid results in depositing in the weld considerable oxide. Purity of the acetylene is demanded, and without going into details it might be said that it is extremely easy to produce acetylene gas which contains elements of a nature which will make the welding seam porous, brittle, and burnt; and this cannot be prevented by skilled manipulation of the torch.

The failure of a welded joint, then, may be traced directly back to the apparatus or gases. Probably this in not usual, but it certainly is possible. Particularly in tension welding, gases must be pure and the apparatus high grade.

Qualities of Material to be Welded.

We are bringing to a melting heat—not a forging one—the metal which is to be bonded; care must be exercised, then, in the purchase of the material to secure the right character of metal suitable for the purpose for which it is to be used, and at the same time favorable to the action of the oxy-acetylene flame. The same general requirements necessary to the successful welding by forge methods are applicable in this instance. Phosphorous and sulphur are, of course, elements which should be present in very small quantities. The carbon point should not be higher than that demanded by the construction requirements, as the higher the carbon content the more difficulties arise in the welding of the metal. Too often the constructor unfamiliar with the requirements of oxy-acetylene welding pays little attention to the fact that this process does demand some thought in the purchase of material which is to be welded.

In the manufacture of a pressure vessel, the sheets should be cut so that when rolled up to form a cylindrical body the edges which are butted will be on a bevel of from 60 to 90 degrees, depending upon the thickness of the material. This V or channel, as shown in Figure 1, must be filled up with other material which is in the form of a welding rod fused a little at a time to the sides of the sheet. Necessarily the welding rod must be of the correct chemical requirements, and the purchase of this rod, which is so often done in a haphazard manner, is one of extreme importance in tension welding.

Preparation of Work.

As outlined in Figure 1, the ideal joint for oxy-acetylene welding is made by butting, with the edges scarfed or beveled as shown. Lap welding by the oxy-acetylene process, while sometimes necessary in repair work, should not be done in constructing new work, for the reason that it is impossible to eliminate layers of oxide in the weld or to get the proper degree of strength.

In designing vessels to contain gases under pressure, the weld should be so arranged that the strain imposed upon the weld is one of tension and not of bending. Note Figures 2 and 3, a common form of construction of cylinders. Here the line of welding is in such a position that the weld is subject to a bending strain. Figure 4 places the line of welding in the right position. These conditions are quite easy to meet in construction work, yet very often—in fact too often—no thought is given to them. Figure 4 is not the only method of inserting the head or bottom of a cylinder to avoid a bending strain. In a short general article of this character principles, rather than details, are advisable. Details may be worked out by the constructor but this principle, that of designing the article to avoid a bending strain on the weld, is an extremely important one in tension welding.

In making manifolds a most desirable method of preparation would be as shown in Fig. 5; but this method is rather difficult of realization for some shops. A more common

form perhaps and one which is not wholly objectionable is as shown in Figure 6. Here the cutting torch is employed to make the opening into the header and to trim to shape the ends of the pipes which are to be welded in. The edges are properly scarfed in the cutting operation and the oxide left by the cutting torch is ground or chiselled off. Edges of the metal are at the proper degree, and the design is such that only a portion of the bending strain is placed upon the weld. The construction as shown in Figure 7 is very bad, a portion of the pipe being lap-welded, and the design poor from a bending strain standpoint.

Requirements of the Welder.

The workman who bonds steel which is to be used for tension purposes must thoroughly understand the process. It does little good to properly prepare the article to be

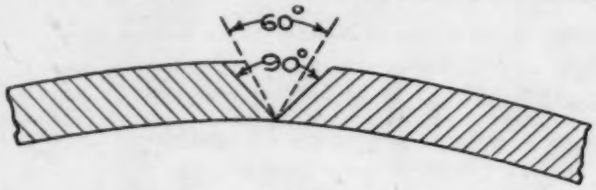


Fig. 1.

welded unless the operation is intelligently carried out. To judge by appearances is deceptive, as it is very easy to make a surface weld of good finish but which may be lacking in quality. A test bar or small piece welded proves nothing, A workman may be entirely competent to weld a couple of inches and wholly incompetent to weld a couple of feet. He may make an ideal job on eighth inch and fall down completely on half inch. The employer must ascertain by test whether the welder is competent. In addition to his qualifications as a workman, he must be conscientious and sober. Making a definite statement as to how much experience he should have before attempting steel welding of an important character, is impossible. He may learn to properly weld in a year and it may take him three or four years; but certainly he should have had at least a year's experience in welding steel not subjected to any particular degree of tension before he is placed on pressure pipe or vessel welding.

It is to be taken for granted that he thoroughly understands the adjustment of the flame to secure a neutral cone and to keep it neutral during the welding operation; to

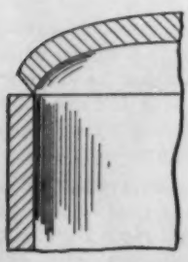


Fig. 2.

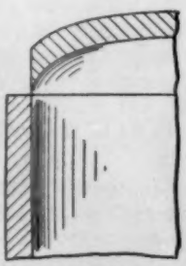


Fig. 3.

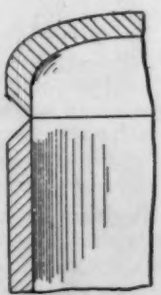


Fig. 4.

properly choose the correct size tip for the thickness of metal to be welded; to be able to bring into fusion the sides of the bevel and the welding rod, secure homogeneity and penetrate through the entire thickness—all this without "burning" the weld.

He should understand the effects of expansion and contraction and know how to guard against their ill-effects by simple means; or, if he does not know this, then the constructor or employer must be able to show him how to avoid contraction stresses, for it is a fact that there are many good welders entirely competent to make a good bond, who will not provide for strains set up by the cooling weld and adjacent metal. If the welder does not understand this phenomenon, it does not necessarily bar him from properly welding tension work providing someone else has so arranged the work as to provide for it. At intervals, some test pieces should be cut from the weld of jobs going through the shop and which the welder does not know is to be tested. If tanks of three to four feet are being made, test pieces should be made cut from one of these tanks and examined to find out if the welder has gone through the entire thickness, if the material added is of the right quality, and if he has paid proper attention to expansion and contraction.

These test pieces may be subjected to simple tests to ascertain the quality of the weld. By grinding and polishing a section and subjecting it to a corrosive acid test, defects such as burning, blowholes, lack of penetration or absence of material, are quickly discernible. Bending tests may of

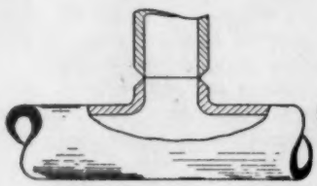


Figure 5

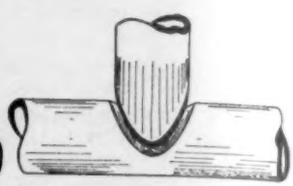


Figure 6

course be made in any shop without any particular equipment. If it is desired to secure data on ductility and tensility, it is only a question of sending the pieces to the proper testing laboratories, but this is really not necessary to check up the qualifications of the welder for ordinary work.

Outlined in detail, the qualifications of a welder appear difficult for the manufacturer to determine, but getting test pieces and subjecting them to the treatment described takes but little time and the results should be well worth the time so spent.

Importance of Expansion and Contraction.

Convincing a workman, and many times an engineer, that cold-metal must occupy a smaller space than hot metal is

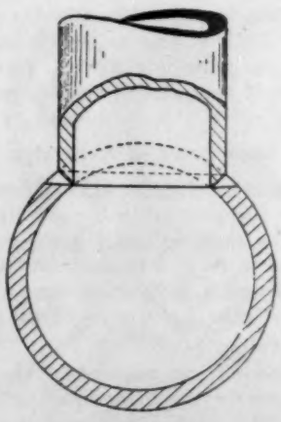


Fig. 7.

a great deal more difficult than would appear from a casual reading of the sentence. The effects of expansion and contraction must be taken into consideration in the planning of the weld to avoid stresses which may be set up either by expansion or contraction or both. It is difficult to outline a general rule for guarding against the ill-effects of this phenomenon which would be applicable in all conditions. Steel being a ductile metal will twist or bend or buckle as a section is heated or cooled, but in doing this there is a strain set up which at some future time is likely to tear open the material at the weakest point.

To illustrate why it is necessary to provide for expansion

and contraction, observe Figure 8, representing the longitudinal seam on a tank. If the edges are brought together and the weld started on one end, it will be noted that as the metal is brought to a welding heat, the other end opens up, caused, of course, by the expansion of the metal on the end which is being welded. As the weld progresses, the end which is open gradually closes, and before the workman has reached the end of the seam, the edges overlap as shown and the article is useless. If, after the operator has progressed a short distance, he realizes that this is occurring, he probably attempts to hold the end open by means of a pin or welding one point or section, "tacking," it is termed, to prevent the sheets from overlapping. Both of these methods are incorrect, for both will distort the tank and set up strains.

This particular class of work may be executed by using a drift pin or wedge in advance of the weld, moving it along as the weld progresses, holding the edges open, so that no severe strains are set up as the metal cools.

The ill-effects of expansion and contraction may also be overcome by spot welding or "tacking" the seam in several places and then bringing the entire line of welding up to a red heat, holding it at that heat while the weld is made, and then allowing it to cool down evenly. Here we expand the entire line of welding to nearly a welding heat, so that the melting by the torch does not set up any material increase of expansion.

It has been suggested that a proper way to weld a longitudinal seam of this character in heavy material is to first weld the entire length of the seam on the bottom only. Then weld another layer, and so on until the seam is completed. Aside from the fact that such a method is extremely uneconomical, due to the wasted heat as we bring to fusion a section and move on without completing the weld in that section, allowing this heat to be absorbed by the material, and burning or oxidation of the metal caused by this rewelding system, such a method sets up expansion and contraction strains which seriously weaken the bond. This perhaps may be better understood by reference to Figure 9, where the weld is divided into six zones and so numbered. Assume that we first "tack" the seam in several places to hold the edges together. Zone No. 1 is then brought to the welding heat and the metal in that zone expands. In doing so it naturally tries to break open the "tacks" in the other zones. If the welds which have first been made are strong enough to prevent this, the molten metal in zone No. 1 is compressed; and in cooling to a solid state, the material which is formed up into a circle becomes slightly oval and the diameter is decreased, as cold metal must occupy a smaller space than hot metal. The welding torch is moved to zone No. 2, and in bringing this section into fusion, strains are again set up in the cooling metal of No. 1, and in zones 3, 4, 5 and 6. In cooling, we again have the rule that cold metal must occupy a smaller space than hot metal, and the line of welding buckles, and severe strains are set up. Continuing this procedure we may readily see that a bond made in this manner is wholly undependable. This is certainly not the fault of the process of oxy-acetylene welding, but it is the result of its faulty application.

The thought may occur to the reader that undue emphasis has been laid upon such a simple fact that cold metal occupies a smaller space than hot metal, and that repetition of this phrase is unnecessary to constructors. Yet it is the violation of, or lack of attention to, this rule which is so many times responsible for failures of oxy-acetylene welded joints.

Let us illustrate this again by Fig. 10, which represents a manifold welded in the usual manner. The dotted lines indicate the natural position of what may be termed the main pipe or header. It will be noted that starting about in the center the main pipe or header starts to curve. This is a daily happening in many shops and the workman is puzzled as to what causes the pipe to bend upwards when he is careful to clamp it into position and to hold these clamps tight while the different welds are being made. The bend is caused, of course, by lack of attention to the rule that cold metal occupies a smaller space than hot metal. The pipes leading away from the header are welded without provision being made to expand that section of the header affected by the cooling metal of the weld; and, as the metal shrinks in the weld it naturally pulls the pipe into the position shown, making it shorter on the top than on the bottom.

These illustrations are taken from actual occurrences which have been noted many times in shops which have had

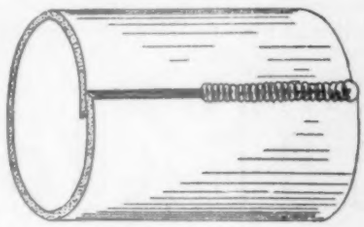


Fig. 8.

considerable experience in the use of the oxy-acetylene flame. They are not theoretical problems.

After-Treatment of the Tension Weld.

If proper attention has been paid to all that has been said regarding the importance of apparatus, material, the workman, expansion and contraction and preparation, and a weld is executed with a full understanding of this elemental knowledge, how good is our weld? And the answer would have to be that for all practical purposes it is as good as we want it. To be sure, the metal added is not the same as the original material was. It has been melted, and after melting has not been subjected to any rolling or forging. The grain is larger and the metal has been over-heated—not burnt, however. Adjoining this material for the entire length of the weld is metal which has been annealed and the grains thus made to come closer together. The elongation of the material in the weld will not be as great as was the original material, but to somewhat offset this, we have made the weld of greater thickness. Just at this time there is a tendency to perhaps over-emphasize this "overheating," as it is called by the welder. It is perfectly practical by easy after-heating and hammering to restore the qualities of the

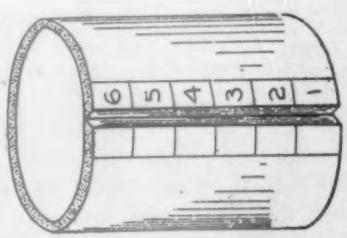


Fig. 9.

metal, but until we are very certain that fundamental principles already outlined are in practice, it is useless to attempt either the understanding of this method or its application.

A casual examination of a ruptured weld will probably show that lack of elemental knowledge was responsible—the material was burnt, the weld made in the wrong location, or stresses set up by failure to properly provide for expansion or contraction—and what is termed the "after-treatment" was not necessary. Hammering and heating an improperly made weld would help but little. The thing to do is to first make a proper weld.

Welding Necessary to the Industry.

No mention has been made of the importance of the oxy-acetylene flame or its wide application to metals other than steel for tension work. There is today hardly any question in any quarter of its time and money-saving qualities in the welding of cast iron; in the foundry filling blowholes and shrinkage cracks; or in the refrigerating plant joining together parts broken by accident, weak design, or freeze-ups. The welding of cast iron is comparatively easy, and welds up to eighteen or twenty inches in thickness are no uncommon. In the remodeling of old plants, the cutting torch is a valuable adjunct, and the welding torch is brought into play in lengthening pipes, putting in tees, etc., and the process is particularly valuable in these instances because of the portability of the necessary apparatus for either cut-

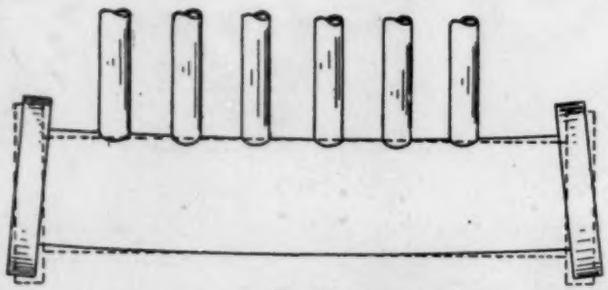


Fig. 10.

ting or welding. Welded ice cans are not unknown, and the tendency to get away from riveted, threaded, or flanged joints in pipes or containers carrying liquids or gases is prevalent in all industries.

The proper use of the oxy-acetylene process not only benefits the constructor in reducing manufacturing costs, but also helps the owner of the plant to operate more economically and with less repairs.

Learning the fundamentals of successful oxy-acetylene welding is not difficult. Give the same thought and study to the process as would be given to any other art or trade. If there is a failure of a welded joint, look first to the method of making it to ascertain the reason for the failure. By grasping the fundamentals of the oxy-acetylene process and putting them into practical operation, it is quite safe to assert there will be no failures.

LIMITATIONS OF THE OXY-ACETYLENE PROCESS*

By Henry Cave.

In the repair of broken parts, a welding operation may often serve as a temporary makeshift, even when subjected to stress, until a new part can be obtained, but caution should be observed when using the process under such conditions. On the other hand, the process can be employed to advantage in many hitherto undeveloped lines.

Accurate work can be done with the process under the right conditions. It is possible to make welds within the limits of machine operation allowances. For instance, it is possible to weld a broken crankshaft from an automobile engine, or other piece of this nature, when the work can be lined up, so that the broken parts are concentric. To do this work satisfactorily not only requires a skilled welder, but one of considerable machine shop experience to line up the parts with the necessary accuracy, *i. e.*, to the thousandth of an inch. In all probability, the welding operation itself will produce a slight bend in the shaft, on account of the variation in the contraction. This is almost sure to occur when one side is completely welded up before the other; for the shrinkage in the welded side will draw the shaft over, and the cooling metal will hold it in that position against the pull of the shrinkage of the metal on the opposite side when it is put in.

In using this illustration, I do not mean to say that I recommend that broken automobile crankshafts be welded. Much depends on the condition of the shaft. The strength of steel is largely dependent upon its heat treatment. Automobile and high-class motor-boat engine crankshafts are made from a grade of steel which, in its raw state, may have had a tensile strength of 75,000 to 90,000 pounds per square inch, but may have been heat treated, however, to a strength of 200,000 to 250,000 pounds per square inch. But even though the weld may be made concentric and may have a very large proportion of the strength of the raw material (if carried out in a careful manner) it is impossible to heat treat the weld, or even the whole shaft, so that the weld will have a strength in any way comparable with the unbroken shaft, and as vibrations and flexure are always located at a weak spot, shafts of this type will assuredly break again in the same place, if subjected to anything like the strain which caused the original break.

The question whether it is advisable to weld parts of this nature depends entirely upon their relative strength in the duties they have to perform, upon the nature of the metal they are made from, and upon the probability of this metal having been heat treated. It will be seen that more satisfactory results will be obtained from the repair of the cheaper grade of crankshaft, but, unfortunately, there is less saving in making repairs on these than on those of the higher class. In some cases the cost of preparing the work, making the weld, straightening the shaft and machining it up, together with the extra fitting of the bearings which it entails, would make up such a sum as to come very close to the cost of a new shaft; and, therefore, there would be no saving, unless a touring party were "hung up" some miles from home.

The repair of parts, the breakage of which might entail a loss of life or limb, is not to be recommended by this or any other process, even though a skilled operator under right conditions *might* make them as strong as the original parts, yet the risk is too great, for he cannot be sure of the nature of the material nor whether it has been heat treated. But frequently it is well worth while to make a temporary repair and to use the part carefully until a new one can be obtained. Reputable job welding concerns should always take this attitude regarding such parts; and it is advisable that they go to the extent of putting into writing that the part may be as strong as it was originally, but, as there is no knowledge of the nature of the metal from which the part was made and as a repair is always more of an uncertainty than a new part, they advise that part be replaced at the first opportunity, keeping the repaired old part for future emergency requirements. It is much the best that a conservative attitude be taken in such matters, for if not explained, should the part break anew, the average user would condemn not only the concern but the process, and the whole oxy-acetylene welding industry would suffer accordingly. * * *

It was found that the use of skilled general welders was not satisfactory. For the ingenuity and nervous activity, almost a requisite in the skilled operator, detracts somewhat from his value in steady repetitive manufacturing work; frequently, too, he loses time by experimenting on other ways of doing the work, instead of sticking to the method which the management had decided was best.

In this particular work it was found that the production by skilled welders was not more than half that by unskilled operators who were merely trained to carry out this one operation. So the work was performed at piece rates at so much per hundred for the different operations. Piece work in the ordinary way, however, is a somewhat questionable arrangement for manufacturing welding, for the time consumed in carrying out the work as well as the consumption of gas, which is practically directly proportional to the time, must be considered. Though the labor cost may be the same with a poor welder as

**Being extracts from one of a series of articles published in Industrial Management.*

with a good welder, the former may use so much oxygen and acetylene as to absorb all the profit on the job.

In order to make piece work a satisfactory arrangement, even with the varying class of operators that were used, each operator was allowed so much oxygen per hundred pieces; this was easily determined, as the oxygen was obtained from individual bottles for each welder. If the allowed amount was exceeded, the cost of the oxygen was charged against the welder; and if the operator made a reduction on the oxygen used per hundred parts, he was given a premium, thus making the cost of the parts practically the same whether made by a skilled or an unskilled operator.

The quantity of filling wire used in a manufacturing process is a very important item, especially at prices now prevailing. Even though the strength of the parts need not be considered, when the poorest grade of work is amply strong for the requirements, the readiness with which the wire flows and covers the surface plays a large part in the cost of making the weld. In a general way the adding material is considered only from the standpoint of the strength and ductility of the weld. This is a great mistake, however, as the actual saving in acetylene, oxygen, and time much more than offsets the difference in cost between a low grade and a high grade wire. In addition the quality of the wire has a marked effect on the porousness of the weld, which is quite a factor where compressed air or gas is to be used. Blow holes may result which are so small that hydraulic pressure may not show them, and yet under gas or air pressure leaks might show up which were entirely due to the quality of the adding material.

An operator, who was turning out steadily, day after day, a high number of parts, because of a rearrangement of the shop found his jig moved to the other end of the floor. His production immediately dropped 25 per cent, notwithstanding his earnest efforts to bring it up to what it had been. Upon returning to his old position, however, he immediately got into step again and produced the full number of parts.

Though sheet metal parts * * * may be welded by unskilled labor with only a few hours experience of welding before actually starting production, rarely does this class of labor fail to provide ample strength in the weld. The principal troubles are not matters of strength, but of blow-holes if a tight weld is required; an unsightly rough appearance in the weld, the operator not having attained that smooth circular movement which gives such a nice appearance to a weld when properly made, and the warping of the sheet, if the work is flat.

An important factor in making satisfactory welds on extremely thin work is the efficiency of the torch. An excess of oxygen, which might not show a very pronounced effect on thicker materials, would seriously affect this thin work, and the effect would be particularly noticeable on such work as an overall buckle, with the joint welded together by the oxy-acetylene process instead of being made by compressing a sleeve over it in the usual manner. In this case the work was turned out automatically. The stiff wire was bent by a machine which threaded the pieces on a long rod. This rod then carried the parts to another machine from which they dropped into a hopper and thence one by one on to a plate; a slide then pushed them forward between two springs, the spring pressure being just sufficient so that the weld could be made without an excess of metal, as would be the case in electric resistance welding. In the machine the part is pushed forward to the full length of the stroke and is stopped right under the oxy-acteylene flame. The machine is timed so that the weld is made during the time the slide repeats its stroke and brings forward the next part which pushes the completed one from between the springs and takes its place. In this way these parts may be welded at the rate of about 100 a minute, whereas the maximum speed that could be obtained by electric butt-welding was about 20 per minute. This is one of the few cases where the oxy-acetylene process encroaches to advantage on the work performed by the electric butt-welding method.

OXY-HYDROGEN.

Editor: Just a few words in regard to the oxy-hydrogen process.

The oxy-hydrogen flame is produced by the combination of two volumes of hydrogen with one volume of oxygen, forming water vapor. These two gases produce a flame of approximately four thousand degrees F. While this temperature is sufficiently high to melt any metal which we have, yet we find it does not produce a very good weld in the welding of steel, as you understand, the gas contains no carbon, the result is, when welding steel the carbon is burnt out to a certain extent, leaving our weld somewhat deficient.

Although in the welding of brass, bronze, copper, aluminum and some of our lower melting metals which have no carbon alloy, this flame is very good, yet when it comes to cutting, this gas is a regular "bear."

In the oxy-hydrogen cutting torch you understand, we use the hydrogen as a pre-heating gas. It is rather difficult for the beginner to adjust this flame, as the hydrogen flame is an orange like flame, with the oxygen added, it is a very pale blue, practically invisible in the sunlight. A good operator soon learns to adjust this torch by hearing it.

After an operator becomes acquainted with the oxy-hydrogen flame as a cutting agent, he would be almost surprised at himself with the rapidity of the cut. Recently I cut with the oxy-hydrogen in competition with the oxy-acetylene. I cut 5-inch shafting in 1 minute and 8 seconds. Oxy-acetylene cutting 5-inch shafting cut in 2, 2¼ and 2½ minutes. We were timed with a stop-watch—our gases were weighed, material also weighed.

I recently made an oxy-hydrogen test, cutting 10-inch risers from steel ingots, cutting time 2 minutes flat by stop-watch. I also was participant in a bridge wrecking job, the bridge being about 700 ft. long. We started in our job with 2 oxy-acetylene cutting torches and 1 oxy-hydrogen cutting torch. At the end of the first day we had cut so much faster with the hydrogen gas that we started the following day discarding the oxy-acetylene equipments entirely.

One would be surprised how clean an oxy-hydrogen cut is. You will understand it is free from carbon, making a nice smooth even cut. Of course the more experience an operator has in any cutting, the better. You can also make a quicker start cutting with hydrogen than you can with the acetylene.

Speaking from experience, I would advise anyone interested in cutting to investigate the use of the oxy-hydrogen for this purpose. Let us hear from some more oxy-hydrogen operators. W. S. Penn.

HYDROGEN IN ACETYLENE CYLINDERS.

Editor: Will you kindly advise if there is any danger connected with filling an empty acetylene gas tank such as is used on automobiles for lighting, with hydrogen gas? If a tank should be cleaned before filling, kindly advise how this could be done. Lake Mills Auto Co.

Answer: Our quick advice to you is to leave the compressing of a combustible gas to those who understand it. Not knowing just how you intend to pump gas into a dissolved acetylene cylinder, we refrain from giving any detailed advice regarding danger but looking at the question solely from a commercial standpoint, why use a perfectly good dissolved acetylene cylinder which is filled with asbestos and in which is undoubtedly considerable acetone? If you must pump hydrogen into a cylinder, why not get an empty tank? But the first line of our answer is the best one for you to follow, leaving the compressing business to those who have made a study of it. If your line of business is such that you must pump hydrogen we would advise that you get acquainted with the fundamentals at some factory where conditions are understood. Editor.

Hints for the Welder

When you finish an interesting piece of work, can you set down on paper the manner in which you went about the job, how you prepared the work and how the job was done? Have you learned some little stunt every welder ought to know? Contributions to this department are paid for. Write it down any old way—I'll polish it up. Make a rough pencil sketch and our draughtsman will fix it up fine. Line drawings are more practical than photographs. Do it today—the men on the firing line are waiting.

L. B. Mackenzie, Editor.

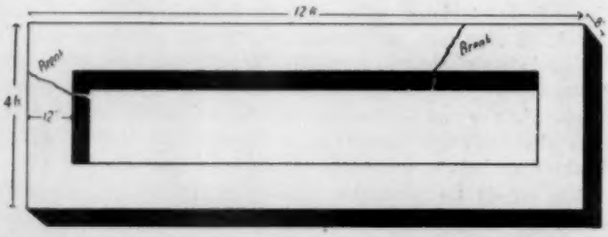
CAST IRON IN CONCRETE.

Editor: I am enclosing a sketch of cast iron base for stationary engine, which is cracked in two places. The base is 12 feet by 4 inches and 12 inches by 8 inches, the breaks are about 15 inches by 8 inches, and the base is set in concrete.

Would like some information as to how to go about welding it if it is within the Oxy-Acetylene Process.

George A. Russ.

Answer: This job is quite within the bounds of the Oxy-Acetylene Process if it is taken out of the concrete, the



breaks beveled from both sides and the casting then treated in the ordinary manner to allow for contraction of the cooling metal of the weld.

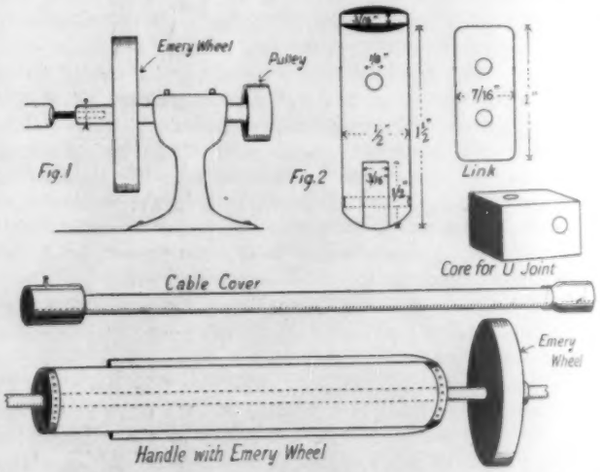
We take it that you are inquiring as to the practicability of making the repair while the base is in the concrete foundation, and in our opinion, this would be a very difficult, if not impossible job. Editor.

FLEXIBLE GRINDING SHAFT.

A good emery stand and a flexible grinding shaft are just as important in a welding shop as a good welding torch. We found it impossible to secure a good reliable flexible shaft until necessity forced the issue and we built one according to our own ideas which we have found not only reliable for all classes of work but absolutely dependable and far better than anything we were able to buy ready-made. For the benefit of others we give directions by which any good mechanic can build his own shaft and at a less cost than he can buy one ready built. Material necessary: 1 6 ft. cover such as used on mule or horse clippers. This is a spiral wire tube, cloth covered with 5/8-in. bore and costs about $4.00. Each end has a cast iron terminal. 6 feet 1/2-in. shafting, 5 feet flat steel 1/8-in x 7/16-in, 12-inch piece of 1-in. gal. water or gas pipe, 16-in. 3/8-in. shafting. 2 sets of motorcycle cones and cups, 2 sets of ball racers with balls, 2 ft. 1/8-in. steel wire—or wire nails will do—2 yokes such as are used on automobile brake rods—1 piece. 1/2-in. square steel 3/4-in. long.

Make a universal joint out of the two yokes and small square piece of steel, by drilling 1/8-in. holes in the small square near center and at right angles to each other. Drill 3/8-in. holes in prongs of yokes and attach to square core with 1/8-in. wire or nails. Then drill a 3/8-in. hole in your emery shaft 2 in. deep and be sure it is straight. This is to furnish power for your flexible shaft. Fit one end of the U-joint in this hole and attach as shown in Fig. 1 so it can be taken out when not in use.

Cut the 1/2-in. shafting into 1 1/2-in. lengths and the flat steel into 1-in. lengths. Cut a 7/16-in. slot in each end of the round pieces a full 1/2-in. deep and at right angles to each other as shown in Fig. 2, with 1-8h hole 1-4 from outside end. Countersink each hole slightly. Drill 3/8-in. hole 1/4-in. from each end in the flat pieces and slightly round the corners. Connect these pieces using the 1-8h wire until you have the desired length and you will then have a continuous



universal joint and this is the flexible shaft. Connect this to one end of the universal joint made out of the brake yokes.

Drill a shallow hole in each end of the gas pipe so as to fit the ball cups. Thread each end of the 16-in. shaft so as to fit the cones and nuts. Connect the shaft and pipe just like a bicycle hub. This is your handle.

Drill out the long iron on end of your cover so as to fit over the end of handle and fasten with the set-screw always in same. Connect your handle with flexible shaft, fill the cover with cup grease, push your shaft through it, attach to your emery stand and you are ready for business. The best connection for the driving end of the shaft is to take a 1 1/2-in. piece of 3/8-in. gas pipe, flatten one end so as to go in one of the slots, and attach the other end to the main U-joint, using the ordinary threaded coupling. In using this shaft the main driving U-joint should always be kept practically straight—the balance of the shaft can be used at any angle desired. J. W. Gannon.

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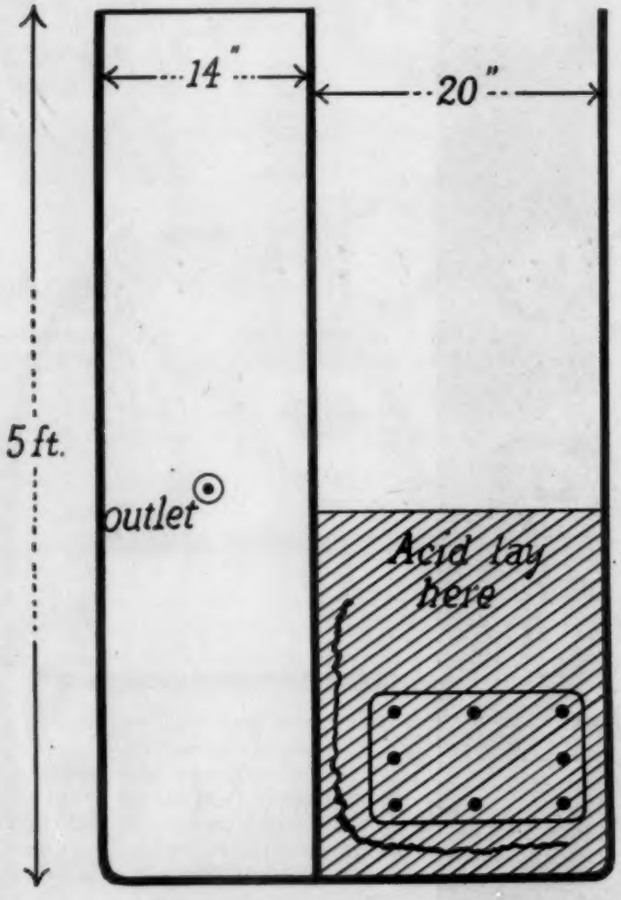
CAST IRON POT.

Editor: This is a job which I was asked to do after a welder failed to make it hold well. He did not preheat properly. This cast iron pot is used in gun cotton plants where the acid runs from nitrating wizard to this pot, which has a perforated screen made of $\frac{1}{16}$-inch iron to strain the cotton and keep it from going into the acid tank. This is the reason the outlet is 2 feet from the bottom of the pot. The acid laying there with the waste cotton caused a steady heat and expansion caused the pot to break. As I outlined, I laid this pot on a couple of bricks, removed 8 nuts, taking off the little plate. I secured sheet metal and made



a small smoke stack and then used a piece of perforated $\frac{1}{16}$-inch iron, laying bricks inside the pot and placing the perforated iron on same. I started my fire which heated to the proper point of expansion and then proceeded to weld. I covered with asbestos enough to leave me space to work on the crack, also keeping the heat from myself. When I completed this weld, I placed more charcoal in fire and covered completely with asbestos, so to cool gradually. This pot was placed in operation the next day, and the weld proved to be stronger than the rest of the pot.

Thomas J. Leddy.

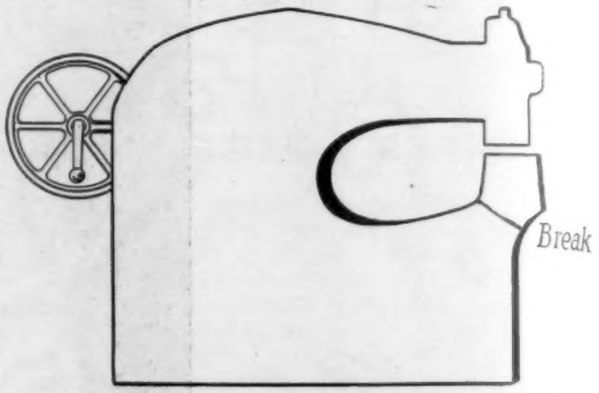
WELDING A PUNCH.

Editor: I am enclosing a rough sketch of a very large punch which I welded some time ago. This punch weighed 12,000 pounds—was used in punching heavy steel girders and like material. It is owned by the Goldberg Structural Steel Co., at Kansas City, Mo.

At the time this punch broke down, being, of course, in their busiest season, as all breaks generally occur, they were doubly put out to find the manufacturer of this punch was engaged in the manufacture of other machinery, consequently a like punch was unobtainable.

They then called on me with my oxy-acetylene equipment. I used two Hauck torches to preheat the jaw, using the torches only to assist us in bringing the metal to a fusing point. After heating this about two hours, of course, we protected the rest of our punch with asbestos, we then built on new metal, making a brand new jaw for this punch. I used 50 pounds of $\frac{1}{4}$-inch cast filler rods and 1 pound of flux; welding time about four hours.

This was an exceedingly hot job and I could not work more than 15 or 20 minutes at a time. The punch is now in operation for about 10 months, working every day and



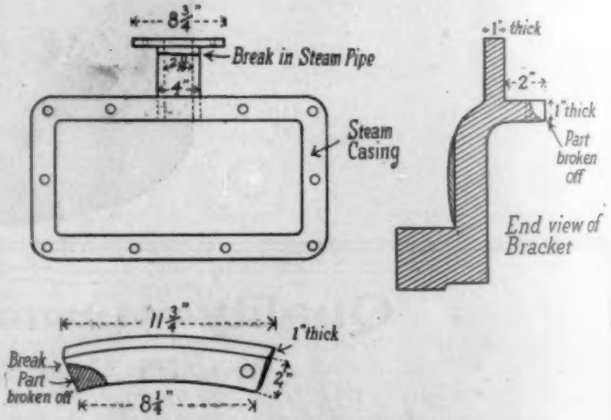
Broken Part Not Used. Built Up Out of New Metal.

giving entire satisfaction. Besides saving this company a large expenditure for a new machine, the oxy-acetylene process has won an everlasting friend with them. On speaking to them some time back, they said they did not see how they had gotten along without it so long. If they could not obtain another welding equipment, money could not buy theirs, as they do a great deal of cutting and all repair work on their broken machinery. We used on this job the Imperial welding equipment, Prest-O-Lite dissolved acetylene and electrolytic oxygen furnished by the Oxygen Gas Co., of Kansas City, Mo.

W. S. Penn.

WELDING A STEAM CHEST.

Editor: The process of oxy-acetylene welding has become almost indispensible to every modern industrial plant. The saving occasioned by its use many times offsets the cost of the entire equipment. Especially in large plants like our



own, the time saved in repairing break-downs in the minimum of time is a great factor in itself. Its applicability to all classes of material and by the use of portable generators, the parts can be welded in situ, which under ordinary circumstances would necessitate their removal to the forge shop or new castings to be made. The facility with which

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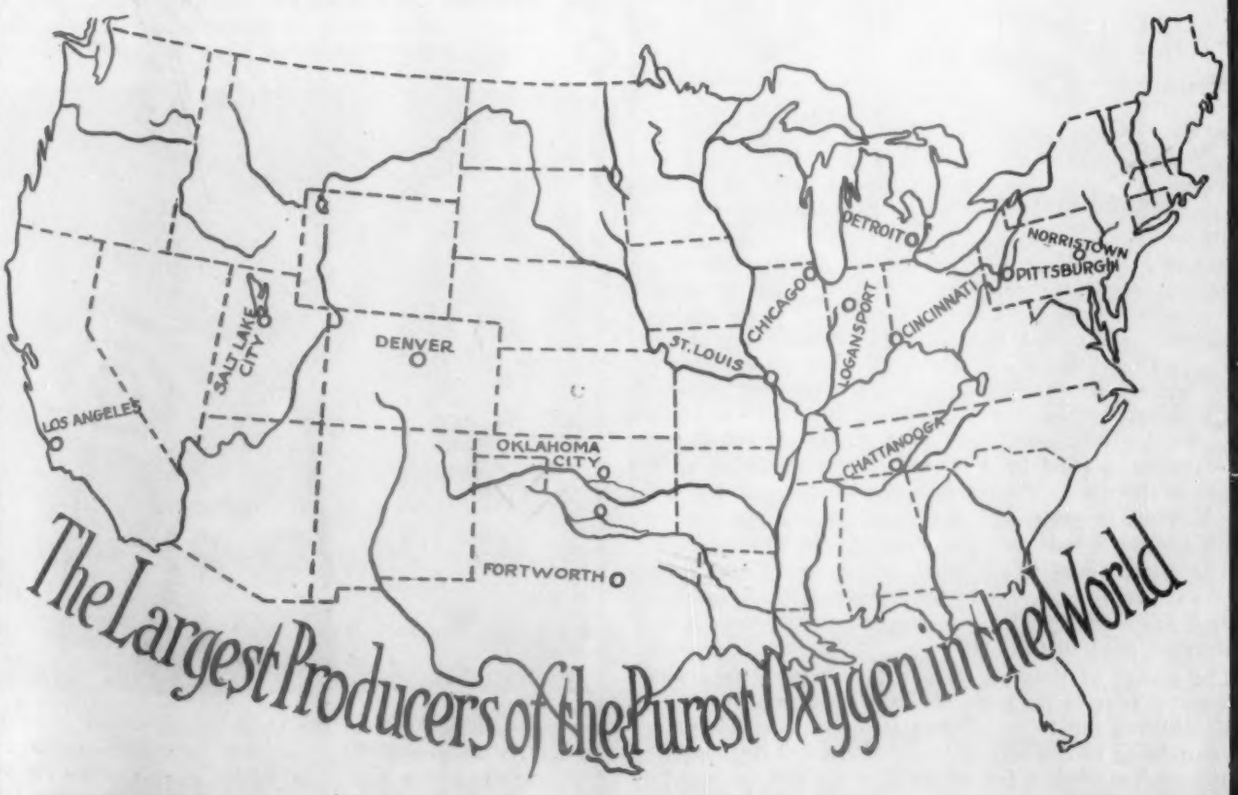

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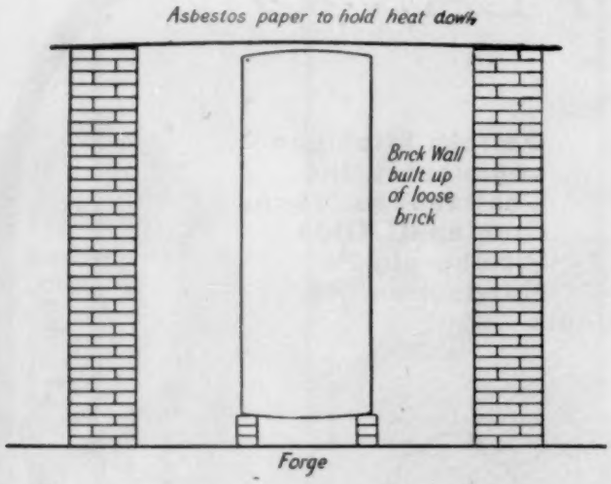
this can be done is one of the chief factors which determine its desirability and commends itself to those who desire to save time and money. I know our company has saved thousands of dollars since they adopted the process at our shop.

I have made a special study of it and watched the progress of it with great pleasure.

Our welders are experts and the class of work they put out is highly commendable.

The enclosed rough sketch shows a steam chest off one of our large shears. The flange was broken off the steam inlet and also the bracket for guiding the eccentric rod had a piece completely broken off as shown. One of the foremen said that it could not be welded. It meant the getting of new castings, delay and expense. I knew we could weld it by oxy-acetylene process, so I had them taken off. The reheating and welding of the flange was done in two hours. The bracket was finished in twenty minutes. A piece of carbon from one of the brushes of a motor was rounded and placed in part of bolt hole left and the new material was added until completed. The work was highly satisfactory and the expense was small compared to the renewing of parts. The reason we can handle break-downs and every-



thing else brought into the shop is that we have a central generating station and the acetylene is piped to all parts of our yard so that we can handle jobs at the shortest possible notice.

I had an excellent piece of welding done last week. A compressor cylinder from one of our mines was brought in on Sunday morning. The outer covering was completely burst from end to end, also the heads were cracked in many places. The cylinder was 16½"x27" external diameter 23". The cylinder was heated almost to a cherry red at the vicinity of the rupture to allow for contraction on cooling. The welding was commenced at 11 A. M. and cylinder and heads were finished by 4 P. M., re-heating taking up 2½ hours of the time. The cylinder was back in working order on Monday morning and everyone was pleased with the work and no complaints have come in regards same.

The installing of this process is one of the best investments the company has indulged in for some time and I feel sure it has a wide field of usefulness and will prove a veritable gold mine to the users.

The saving of time as compared with the delays which frequently arise in the replacement of parts, and the facility with which it can be handled in almost inaccessible places, its portability to the seat of break-downs and the durability of the work are only a few of the factors which command its usefulness. The advantages are almost inestimable.

W. E. Brooks.

WELDING AN ENGINE BLOCK.

Editor: Please find enclosed two photos of an engine block which we welded some time ago and as this was a very small matter and the block cracked from freezing, made the job difficult to weld as we had to figure how we were going to weld it and save the block. This engine has a water hopper on top of the block as well as a water jacket, which is cracked by the mark "X" which you will see. The two photos show the block before and after welding. Now the engine

is a two-cylinder affair and while it is a two-cylinder engine, it has only one connecting rod, which is connected to both pistons at the center by a cross pin which takes both pistons near the center. The large hole marked "X" is to get at the connecting rod at the pistons for tightening the piston head pins or rather the cross head pins as they are called. The pin is put in at the left side where the nipple and elbow

are screwed into side of the block as the pistons are very long. As the connecting rod has to work between the pistons this casting had to be welded so as not to warp the bore of the cylinders. From the two cuts you can see that we made a smooth job of it. We figured that the job would

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In order to turn out a finished job every welding shop must be equipped to not only handle heavy work, but also handle it with the least possible effort and in the shortest space of time. The time of a skilled welder is valuable and every time-saving tool you can place in his hands will increase the capacity of your shop. These tools pay for themselves in a short time.

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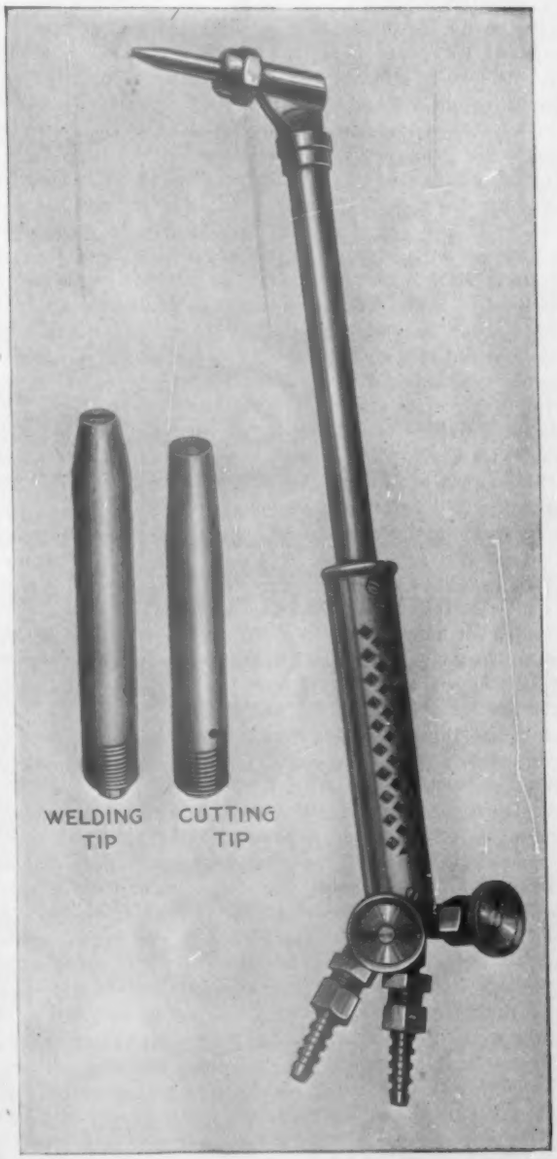

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be easy to weld but would warp and probably crack if we didn't prepare for shrinking and expansion. We used charcoal for a base of fire, but not very heavy, only enough to keep the casting from getting any draught under it. We started the fire and when the charcoal was burned down to a good bed of coals, we worked a couple of fire bricks down in the fire of coals and laid the casting on them just above the bed of charcoal fire, then we would have room to weld, allowing our wall to be about the thickness of a brick above the casting so we could move it over and off the crack. We left the bottom of the casting open so we could get the torch burner so we could blow the flame through the cylinder bore. We then allowed the wall of the furnace to come within a couple of inches of top head as marked "X," and when we turned the flame of the torch on it the flame blew through the cylinders and struck the brick wall, which we built up and baffled the flame, causing it to reflect back against the head of the engine block, and by this the flame forced in the core and around the outside of the cylinder wall and on the inside of the jacket by the head from the charcoal and the head from the gas torch. We got the finest kind of heat. From the two cuts you can see that the job was all O. K. and was absolutely true and when cooled we cleared the casting and oiled it inside, and as the pistons had no rings and had to fit close to make a tight fit, they went in the cylinders as fine as a casting could fit.

We have welded several cylinders this way and every job has been an O. K. job. If a man who pretends to do welding can't figure out how to take care of expansion and contraction, he had better not undertake welding. I put more time in studying how to do a job than it takes sometimes to do it. Wm. D. Troutner.

THE RIGHT WELDING RODS.

Editor: We note a letter in the recent issue of *The Welding Engineer* from Mr. George P. Risser.

Mr. Risser wants to know how he is going to tell when he has the right kind of welding rods.

The safest thing for Mr. Risser to do is to buy welding rods and fluxes from a reputable concern, one that makes a specialty of such materials.

Ever since we have manufactured oxy-acetylene welding equipment, we have given a great deal of attention to the development of welding rods and fluxes. Through our Research and Experimental Departments, and as a result of our many years' of experience in this field, we have developed analyses and specifications and are in a position to furnish welding rods that we believe to be most adaptable for use in connection with the oxy-acetylene process.

As in the case of many articles in general use, the prices of welding supplies show a wide range. Many concerns in purchasing such materials are governed entirely by price. This is obviously the wrong idea. It is not economy for a man to buy cheap welding rods of inferior quality if he can obtain far better results from a higher grade, and naturally more expensive rods. If the writer wants to buy a fountain pen, he does not try to find the cheapest one that can be obtained, nor does he try to make one. He goes to a reputable concern that makes a specialty of the manufacture of such an article.

C. L. Brand, Manager Supply Dept.,
Davis-Bournonville Co.

WELDING TUBING.

Editor: I have read some of your items with reference to welding.

It might be of interest to you to know that we manufacture cold rolled steel tubing by the oxy-acetylene welding process. The tube is 20 gauge, ¾ of an inch outside diameter and stands 3,000 pounds hydraulic pressure. At this pressure the tube bulges considerably and at greater pressures the tube will burst, but not at the weld or near the weld. Such strength as this should prove that welded joints should be satisfactory for refrigeration, etc. The seam of this tube is welded without the addition of any extra metal of any kind.

The Lloyd Manufacturing Co.,
F. C. Lloyd, Secretary.

OLD STOVE FOR PREHEATING.

Editor:

I have been taking your monthly magazine for about a year and find it very instructive and would like to do something to help along the work. I have had a welding and cutting outfit for about two years and I am getting along fine, thanks to your magazine. I did a job the other day that might help some other welder. I have made a rough drawing of it. The pieces were lost, so it was up to me to fill it in, which I did with a piece of an old lumber wagon boxing and it looked fine and stood the test. It belongs to a pump of a tug. The way I preheated: I have an old box stove without bolts in it, so I lifted the top off, packed in some hard wood and then put the pump head on top and got a big fire on. When good and hot I welded one part, turned it over, welded the other side through the door of the stove and then built another fire and let it all cool down together. I use the old stove a lot for preheating. I hope this will help some brother welder. W. E. Rodgers.

PATCHING FIRE BOXES.

Inlaid patches of fire boxes of boilers have been tried in many ways, but have not been successful where two horizontal welds must be made, on account of the contraction and expansion being so great.

When the second weld is being made, it will crack the first. I have tried the lap welded patches and find them to be a failure and have also tried the round patch, dishing same and using flatter and sledge, hammering dish out. They also failed in many fire boxes. By corrugating patches to take up contraction and expansion, I have found them to be very successful in many cases where these patches can be used conveniently.

Side sheets often crack in locomotive fire boxes up a row of staybolts two or three feet in length. In order to weld an inlaid patch in a place of this kind, it would be necessary to cut two rows of staybolts making sure to get to the end of the crack and boring space of one inch and a half each side of staybolts for weld. The patch must be made with three-quarters of an inch corrugation fitted in place with not more than three-sixteenths opening leveled to forty-five degrees. The patch may be held in place by taping every other staybolt, screwing staybolts in same so as to hold patch. Flush with the sheet the staybolts can be put in through the outside sheet and three-quarter bolt through the fire box side to hold patch secure. When welding, weld may be started from bottom on either side.

Continue weld until opening closes, then start on the other side and continue first one side and then the other until the top of patch is reached, welding top last. I have known of two of these patches that have been welded in alongside of brick arch and have been in service for nearly a year and have given no trouble as yet. Glen Loucks.

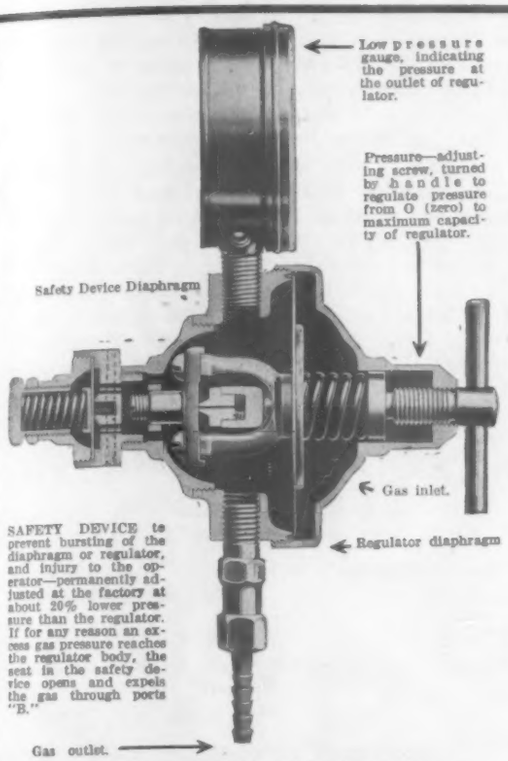
WATER JACKET.

Editor: Several years ago I had a large gas engine cylinder brought to me, which had a large part of the water jacket broken out from water freezing in it.

This cylinder weighed several hundred pounds and measured some 3 feet long and had a bore of 8 inches.

The metal of water jacket was between ⅜ inch and ⅝ inch thick, so you can understand it was not a light piece and had to be preheated.

The job was first undertaken where they were not equipped to preheat large castings. The way they undertook to pre-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How often have you heard of a serious accident because of the poor design or weakness of a regulator? Because of the nature of oxy-acetylene welding and cutting, it is of the utmost importance that the apparatus used be properly designed and made to insure the operator.

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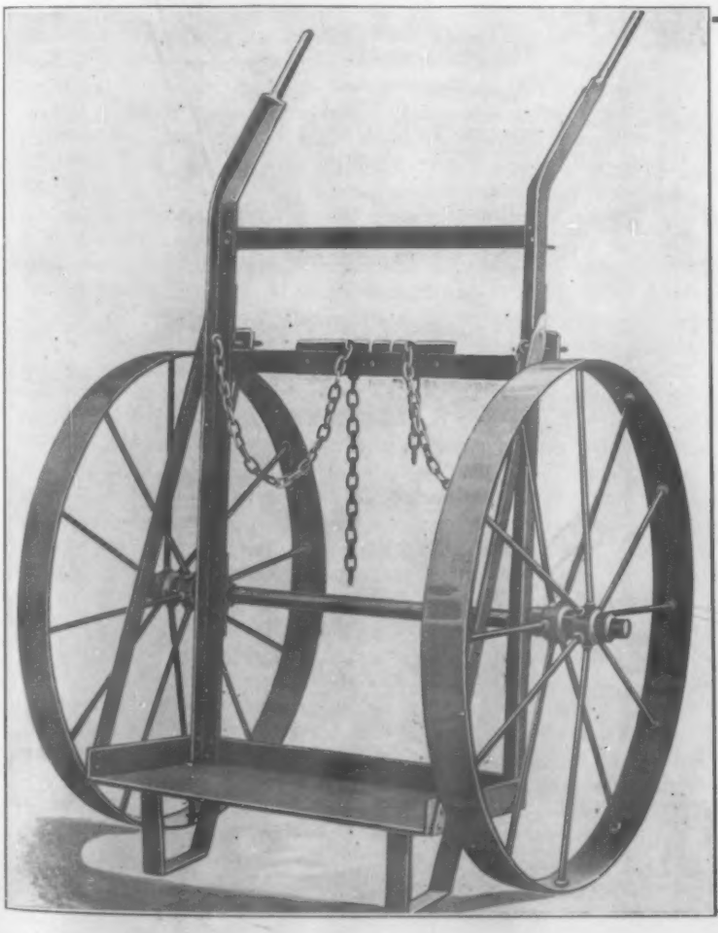

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Frame made of angle, well braced, riveted and set in perfect balance. Bottom holder formed of heavy plate steel. Wheels 33 inch with 3 inch tire. Axle 1¼ inch round steel. Chain holders are easily adjusted, fitting any size tank and can be released by one or two turns of adjusting screw. Adjustable Torch Holder to fit all makes torches.

Welder can handle 300 foot acetylene and 250 foot oxygen tanks with perfect ease—the large wheels and balance do it. Can not turn over.

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heat was to lay it on a cement floor and build a bonfire over it of light sticks of wood. Of course, they did not weld cylinder or even get started. After it was cool enough to handle, they brought it to me. I looked at it and knew I could weld it, but being busy I did not take a close look, and when my helper felt inside he found the bore was cracked all the way around and so badly warped that part of the bore had jumped to one side ⅛ inch.

It was ruined as far as a practical repair was concerned. This was in the early days of my own welding and I thought I had the reason all figured out why it cracked and how I was going to handle that kind of a job.

I did not have long to wait till some kind of a cylinder came in. I chamfered out the crack and layed the cylinder on a brick forge and built a brick wall around it, started a good charcoal fire and covered with asbestos paper.

After the fire had been going an hour or so, I found out that my method was no better than the other fellow's, as the inside or bore of the cylinder broke with a sharp ping, making junk of an expensive piece and losing the money I would have gotten if the welding had been successful.

To say that I was discouraged would be putting it mildly. I was discouraged, but not defeated. I was ready to try it over again.

When the next one came in I set it on end and on several bricks as per drawing.

I started a charcoal fire under the end and built a fire inside of the cylinder as well as outside so heat would pass up both inside and around outside. Thus both inside and outside would expand equally and at the same time, for if one or the other expands faster, one would have to crack.

A study of cross section would make my meaning clearer. It is in fact, two cylinders fastened together at the ends.

Enough to say that I was successful in welding and have used the method many times, so feel it has been fully tried and will pass it on to help some other beginner.

There is also a moral to this history and that is, no matter what your failures are, use your head and try again. Success is sure to come.

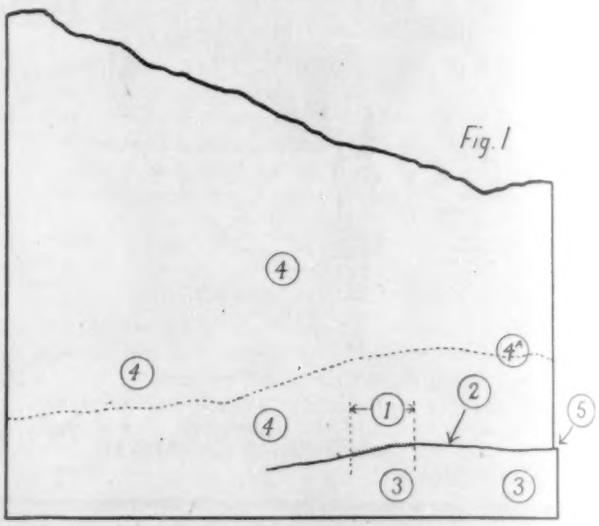
Miller Welding Works.

EXPANSION AND CONTRACTION.

By O. N. Crispell.

I notice a great deal of discussion about the best way to handle the welders' old enemy, "Mr. Expansion." All sorts of fancy figures seem to be advanced, but plain common old friend, "Hoss Sense," seems to be left entirely out of the arguments. Experience has taught me that an easy way to handle Mr. Expansion, on castings in which the break is all the way through section, broken part being held in a rigid position by other parts of the castings, such as wheels and cracks in cylinders that represent a plate with a crack in its center, is to preheat at such places as would cause the crack to open up in a straight line. Now all this is precisely the same as others have described, but my method deals with getting as near the right clearance as possible before starting to weld. To this end I proceed by making a taper-gage of a piece of soft iron by hammering. There a suitable part of the weld is hack sawed until the projecting parts on opposite sides face each other and clear each other, but are close enough to allow measuring by the taper gage. The gage is then pushed in until it makes solid contact and its position noted and marked on the edge with a file. This is first done when cold, then heat is applied at such places as will cause the crack to open up as before described. At the same time the weld is heated to a good cherry red or near the melting point, either with the torch or charcoal, preferably the latter. These heats are managed so that with the fracture nearly ready to melt the gage will go to the same place with the same pressure as cold. It is needless to say that the fires should be kept up quite evenly until the weld is finished. Of course there are exceptions to all rules, such as the rim of a gear that has cracked and opened up between the teeth. In this case the welder will have to put the parts back to their original form to make the teeth mesh properly. Some times he may be able to eliminate the strain though by a cut and weld at some other place. From the above it will be seen that the welder is in a position to correct the faults of the foundry, but he must exercise great care and precision along with his "hoss sense" and must remember that his false moves are like those of a surgeon's, likely to result in failure if the right thing isn't done at the right time.

Now in regard to cracks that do not reach the edge of the plate, such as automobile cylinders. I have had the best of luck by heating the whole casting to a good red before starting to weld and letting it cool down in the fire after welding. If the casting is a large one, with a small crack, of course it is plain



that the whole need not be heated, but care must be exercised or the heat may cause a break some other place. Drawing No. 1 shows a mistake that I made a while ago, though in this case it was lack of heat and the crack occurred on cooling. I prefer charcoal for heating and use brick for some kinds of work while in some cases ordinary sheet tin does the work well. On cylinders I use about 2 inch space all around and see that the fire does not get in the bore. Where threads are exposed I cover up with wet asbestos and band with soft iron wire if possible.

Another little trick of expansion that is too often overlooked occurs from failure to keep the weld at a good red all the way through during welding and results in a bend if the ends are free to move. However the explanation is simple, for when the welder starts his weld he has his metal at the highest point of expansion and as soon as he proceeds upward the lower part starts to cool and contract while the upper part is kept at the full expansion point until the weld is complete. Then on cooling the last part of the weld or top has the full amount to contract while the lower has already contracted a part of the way dragging the top part together a trifle while it was being put in, so when cold the top part has a drawing action which causes the part to be bent or sprung with the last part of the weld on the inside of the bend. Thus: (Greatly exaggerated.)

Last summer while doing some work for the Standard Oil Co., at Bayway, N. J., I came across another little kink in steel welding. This particular job was a 30-inch crack in ⅝-inch boiler plate on one of the large stills that are used for the new process of "getting more gasoline." The stills were 32 ft. long by 10 ft. diameter, and on top of this I was given to understand before starting that the test would be first a good hammering by two picked "huskies" with 16-lb. malls. Then the cold water pressure of 160 lbs. was applied and again the boiler makers tried their luck. They had the plate already beveled when I got there. This was done in the usual way, but the bottom of

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and V was ⅛ inch from the bottom of the plate when they stopped chipping. Then a part of the crack was heated to a dull red and the bottom bent down about a quarter of an inch.

Fig. 2.

This made it look like Fig. 2. This made a reinforcing on the inside and I might also mention that I took care of expansion or rather contraction by hammering to stretch. But it seems that the idea is a good one, as I never saw it before.

A CORRECTION.

In the March issue of *The Welding Engineer* we referred to an article on oxy-acetylene welding, published in *The Travelers' Standard*, as being misleading and uniformative. This was wholly an error on the part of the editor, the criticism being intended for another article entirely. The article in *The Travelers' Standard* was not only well written but also reflects the interest which is being taken in the subject of welding by big insurance companies.

TRADE NEWS.

The Stow Manufacturing Co., Binghamton, N. Y., have issued a new bulletin devoted to flexible shafting. This shafting is in use by many welding shops in connection with grinding machines. A copy of the bulletin, No. 102-W, will be sent upon request.

The Hauck Mfg. Co., 140 Livingston street, Brooklyn, N. Y., have issued two bulletins which will be of particular interest to welders. Bulletin No. 75-W is entitled "Useful Hints for Quick Auto Repairs." It contains a great many illustrations and a mass of useful information. Bulletin No. 76-W is entitled "Practical Applications in Machine Shops." This bulletin will be of particular interest to welders handling a variety of work. Copies will be sent upon request.

The Western Welding & Equipment Co., Karpen Bldg., Chicago, are the new Chicago representatives for the Lincoln Electric Co., of Cleveland, manufacturers of arc welding equipment. Mr. C. Gale Adams is in charge.

Mr. Thomas T. Richey, a director and valued employe of The Great Lakes Welding Co., Cleveland, was recently killed in the collapse of a structure which the company was dismantling.

Mr. J. L. Wright, formerly a partner in the Commercial Welding Co., Commerce, Okla., has purchased an interest in the Mulberry Boiler Works, Mulberry, Kans.

The corporate name of the Southern Illinois Machine & Foundry Co., Murphysboro, Ill., has been changed to the Egyptian Iron Works. A large increase in business necessitates the building of a new foundry building and a car shop, for the manufacture of complete mining cars, as well as other mining equipment.

Augustine Davis, president Davis-Bournonville Co., Jersey City, made an address March 16 before 500 employees of the company, organized as a club, at a social entertainment at the Masonic Temple, Jersey City.

Classified Ads

Help Wanted—25c per line, minimum 4 lines.
Jobs Wanted—4 lines free.
Other Ads—50c per line, minimum 4 lines.
Count 8 words to line. Add 6 words for keyed address.

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Job Wanted—Man experienced as Brazier and as welder in small work. No experience in large. Good mechanic. Will go anywhere. Have been foreman. Address M-2, care of The Welding Engineer.

Wanted—Salesman to solicit subscriptions to *The Welding Engineer*, or furnish names of possible readers. Compensation good. Correspondence confidential. Write Mackenzie.

Wanted—First-class oxy-acetylene welder for all kinds of jobbing work, mostly broken coal mining machinery, such as gears, mine locomotive castings, etc., in cast iron, steel and brass. Must be especially good on heavy, intricate machine work. Man with blacksmith, boilermaking or machinist experience preferred. Steady employment at such work when not otherwise engaged. State age, pay expected and furnish best of references as to capability and habits. Address Egyptian Iron Works, Murphysboro, Ill.

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STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912,

of *The Welding Engineer*, published monthly at Chicago, Ill., for April, 1917.

State of Illinois, County of Cook, ss.

Before me, a Notary Public in and for the state and county aforesaid, personally appeared L. B. MacKenzie, who, having been duly sworn according to law, deposes and says that he is the editor of *The Welding Engineer*, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to-wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, The Welding Engineer Publishing Co., 608 S. Dearborn St.

Editor, L. B. MacKenzie, 608 S. Dearborn St.

Managing Editor, none.

Business Manager, L. B. MacKenzie, 608 S. Dearborn St.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)

L. B. MacKenzie, 608 S. Dearborn St.
H. L. Patterson, 29 S. La Salle St.
A. D. Cloud, 110 S. Dearborn St.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)

None.

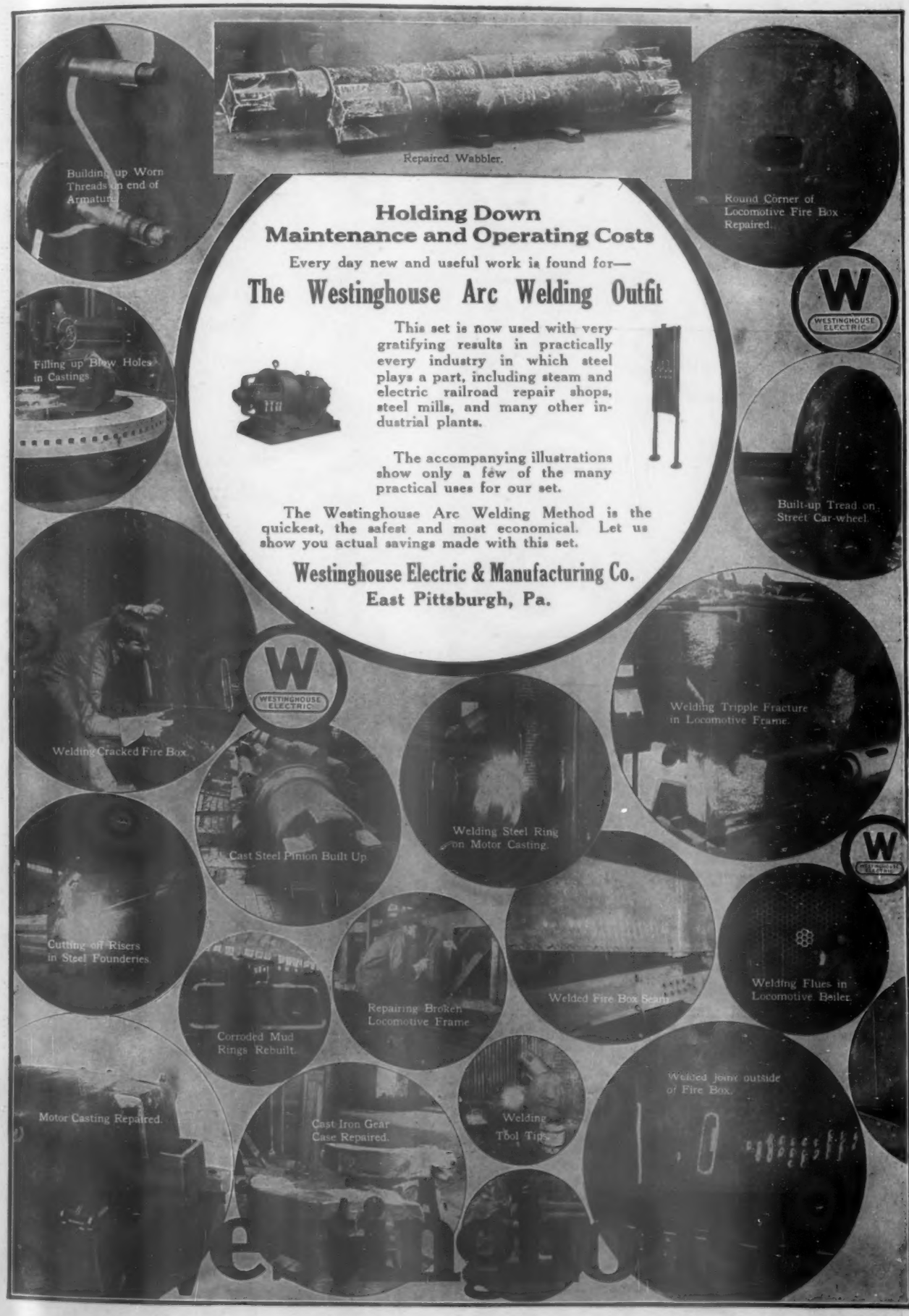
4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

L. B. Mackenzie.

Sworn to and subscribed before me this 18th day of April, 1917.

(SEAL) Hilma A. Hansen.

(My commission expires Dec. 20th, 1919.)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Welded joint outside of Fire Box.

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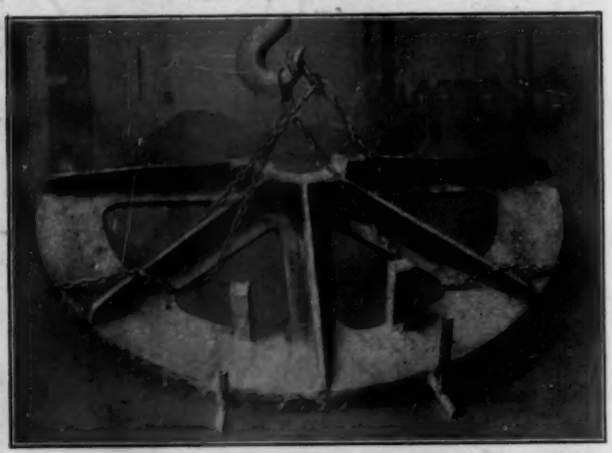
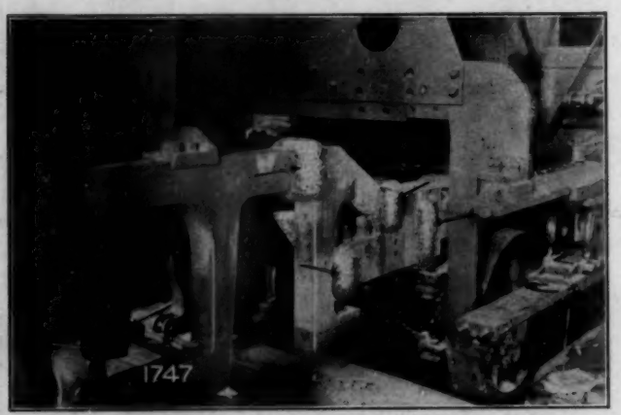
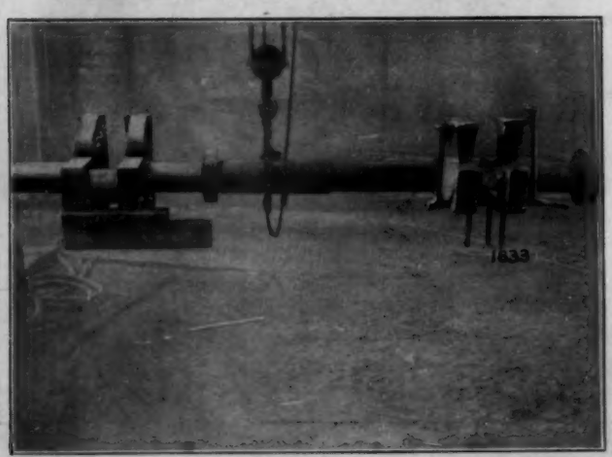


Large bevel gear on which two new teeth and crack have been repaired.



Four Thermit welds on locomotive frame on the Missouri Pacific Railroad, made without removing the frame from place.



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